ADVANCED COMPUTER-BASED MANUFACTURING SYSTEMS FOR DEFENSE NEEDS

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Prepared for:

Advanced Research Projects Agency

September 1973

AD-769 109

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) USC Information Sciences Institute 4676 Admiralty Way Marina del Rey, California 90291	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP -

3. REPORT TITLE

"Advanced Computer-Based Manufacturing Systems for Defense Needs"

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Research Report

5. AUTHOR(S) (First name, middle initial, last name)

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6. REPORT DATE September 1973	7a. TOTAL NO. OF PAGES 218	7b. NO. OF REFS
8a. CONTRACT OR GRANT NO DAHC 15 72 C 0308 b. PROJECT NO ARPA Order #2223/1 c. Program Code No. 3D30 and 3P10 d.	9a. ORIGINATOR'S REPORT NUMBER(S) ISI/RR-73-10 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) none	

10. DISTRIBUTION STATEMENT

Approved for release; distribution unlimited

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Advanced Research Projects Agency 1400 Wilson Boulevard Arlington, Virginia 22209

13. ABSTRACT

This Programmed Automation report evaluates the feasibility and impact of advanced computer-based manufacturing systems for discrete precision products in defense-related industries. This final report on the project study phase includes both an economic analysis of DOD procurement and case analyses of specific manufacturing operations.

Allocation and control of resources in complex batch manufacturing environments is the greatest problem on which computers can now have a major impact; recommendations are made for such an interactive production control system. Conclusions and recommendations on the application of robotics technology in manufacturing automation are also given.

* *

14. Keywords: Automation, Assembly, Batch Production, Computer-Aided Manufacturing (CAM), DOD Procurement, Management Information System (MIS), Manufacturing Systems, Numerical Control (N/C), Process Control, Production Control, Productivity, Robotics.

DD FORM 1 NOV 65 1473

Security Classification

ARPA ORDER NO. 2223/1

ISI/RR—73—10
September 1973

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Advanced Computer-Based Manufacturing Systems for Defense Needs

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THIS RESEARCH IS SUPPORTED BY THE ADVANCED RESEARCH PROJECTS AGENCY UNDER CONTRACT NO. DAHC15 72 C 0308. ARPA ORDER NO. 2223/1. PROGRAM CODE NO. 3D30 AND 3P10.

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ABSTRACT

U.S. manufacturers of discrete products must increase their productivity significantly to remain competitive in world markets; the long-term stability of the U.S. economy depends on this competitive position. The Department of Defense procures over $20 billion worth of discrete goods each year. The great majority of these goods are sophisticated, precision products -- often electronic-based -- procured in rather small quantities. They are predominantly batch-produced. It is precisely in this category of discrete manufactured products that: (1) the U.S. has a comparative advantage in world markets, and (2) DOD requires healthy, efficient, national manufacturing support.

Batch manufacture of discrete precision products is characterized by a dynamic environment with continually changing priorities and job mix. We examined a wide range of potential computer-based manufacturing systems for increasing manufacturing productivity, ranging from near-total programmable automation of manufacturing -- including assembly and inspection processes -- to incremental enhancements of existing systems. We concluded that the greatest potential source of productivity improvement for the batch manufacturing environment is the effective, interactive use of computers for accurate up-to-date status information for management, and for allocation, control, and monitoring of production resources. Computers are not now being used effectively for these purposes due to the inflexibility of existing software, the lack of interfaces natural to managers in this environment, and insufficient real time status-reporting from the production processes.

The required software systems must be usable directly by a manager and must be modifiable by him; they most probably will require some modeling, deductive, decision-making, and language-understanding capabilities. We urge the development of a demonstration system having these features, based on a graduated R & D program that allows measurement and analysis of the relevant transactions within the manufacturing environment before the final management control system is developed. Effective control software for complex batch production environments is a necessary precursor to efficient use of other advanced automation technologies, such as automated assembly and inspection systems. The primary direct benefits of an effective batch production management system are: (1) reduced inventory costs; (2) greater productivity through higher utilization of resources; (3) better ability to meet schedules, resulting in less slippage, defaults, and cost overruns. Due to the high degree of concentration of DOD procurement in a few major industries, the introduction of advanced computer-based manufacturing systems into these key industries can have a major impact in a relatively short time.

Our second recommendation is that research be continued in computer-controlled manipulation of objects, with particular emphasis on the mechanical dexterity required in assembly of avionic packages and other electronic-based units. We concluded that assembly and testing operations of this scale will not be eliminated by the continuing revolution in electronic components, and will be of increasing importance in batch-made products procured by DOD; this same class of electronic-based products is also particularly crucial to the long-term U.S. balance of trade.

The batch production manufacturing environment requires a sophistication in computer-based management and resource control systems that is not available commercially, but elements of which have been demonstrated in research laboratories, particularly within the ARPA contractor community. Those research capabilities must now be transferred to practical, commercial use.

ACKNOWLEDGMENTS

The following members of the Information Sciences Institute made substantial, continuing contributions to this report:

Dr. Karl Balke
Ernest M. Hinds
Dr. Gopal Kadekodi
Paul Lande
Dr. Bennet Lientz
Dr. Elliot Ponchick

The following individuals have made important contributions as consultants to the project:

Dr. Michael Boretsky
U.S. Department of Commerce

Alexander F. Brewer
SpectraVision, Inc.

Vernon Edwards
SpectraVision, Inc.

Jack Rosenberg
Consultant

To help validate the conclusions and recommendations in this report, we asked a select group of managers with direct responsibility for manufacturing operations in firms representative of DOD suppliers to sit as an advisory council to this project. Members of this council are:

Mr. William D. Beeby
Manager, Process Assembly
The Boeing Company
Seattle, Washington

Mr. Clint T. Hays
Manager, N/C Fabrication
Douglas Aircraft Company
Torrance, California

Mr. Ronald Patitz
Manufacturing Manager
Precision Products Division
Western Gear Corporation
Lynwood, California

These persons have contributed significant time and effort to the project, for which we are very grateful. In addition, Mr. Harry Davis, Assistant Division Manager, Tucson Division, Hughes Aircraft Company, has been extremely helpful in our study of TOW missile manufacture.

PREFACE

In October 1971, a research effort was begun at the request of the Advanced Research Projects Agency of the Department of Defense to investigate the feasibility of significant production advancements using computer-based manufacturing technology and to evaluate the impact such advancements might have on DOD procurement of manufactured goods.

The research program was initiated by members of the Computer Sciences Department of The Rand Corporation. In July 1972, this investigation was transferred to the newly-formed University of Southern California Information Sciences Institute. This report is the final one on the study phase of this research program.

This report presents specific recommendations for a major high-impact ARPA-sponsored research and development program in advanced computer-based manufacturing technology, including the objectives, required level of effort, milestones, and duration of such a program. The economic analysis in this report also provides a major source of information on many key characteristics of DOD-related manufacturing industries. The data obtained in the course of our study will be of great importance to other governmental agencies and to research contractors in formulating and evaluating complementary research and development programs in computer-based manufacturing.

I. INTRODUCTION

The Information Processing Techniques (IPT) Directorate of the Advanced Research Projects Agency (ARPA) in the Department of Defense has been responsible for much of the advanced computer science research and development in the United States during the past decade. Foremost among these development programs are time sharing systems, large-scale array computers, artificial intelligence research, and distributed digital communications networks. The technical characteristics of many experimental hardware and software systems demonstrated by ARPA contractors far exceed the characteristics of systems commercially available today.

One of DOD's most vital requirements, to which ARPA research is directly relevant, is the maximum possible effectiveness of weapons systems and equipment purchased -- the most bang for the buck. This is all the more important since, as discussed in Section II, the real purchasing power of DOD's procurement budget has declined significantly in the past 10 years. To even maintain existing levels of defense weapons systems effectiveness, the productivity of DOD suppliers must be increased, allowing more systems and equipment to be purchased for a given level of expenditure.

The importance of manufacturing productivity, not only to DOD but to the U.S. economy, is underscored by several other significant trends: (1) the recurring balance of payments problem faced by the U.S., due primarily to our high manufacturing costs relative to foreign competitors; (2) the aggressive, unified, large-scale developmental programs in manufacturing automation technologies being undertaken by our principal foreign competitors, notably Japan.

All of the above considerations led a group of key ARPA IPT principal research contractors in spring 1971 to recommend that ARPA investigate the opportunities for applying its unique computer science capabilities to increasing manufacturing productivity. In summer 1971, a research group within the Computer Sciences Department of The Rand Corporation, Santa Monica, California, was asked by ARPA to conduct such an investigation. In July, 1972, that investigation was transferred to the newly-formed University of Southern California Information Sciences Institute. During the past 24 months, members of this study group met with over 100 representatives of industry, research groups, and the government, and inspected over 30 different manufacturing facilities throughout the U.S. covering a wide range of products and technologies. Appendix A of this report contains a list of the major contacts made during the course of this investigation.

To discuss the potential impact of advanced computer-based systems on manufacturing productivity -- and particularly on DOD procurement of manufactured goods -- it is important to understand the unique

characteristics of the products that DOD procures, the relative importance of certain key products, and the characteristics of the industries that are major DOD suppliers. Section II of this report analyzes some of the important characteristics of DOD procurement and draws some important conclusions about the priorities and areas of concentration that must be addressed by any major development program purporting to have a significant beneficial effect on DOD procurement.

Section III discusses in detail three case studies we performed of manufacturing enterprises which produce discrete goods for DOD end use, with the conclusions we drew from these studies.

Section IV contains explicit recommendations to ARPA for support of a major research and development program in computer-based manufacturing.

II. IMPORTANT CHARACTERISTICS OF DOD PROCUREMENT

The policies and programs under which the Department of Defense procures manufactured goods are extremely complex. The characteristics of both the manufactured goods bought by DOD and the industries supplying these goods differ markedly from the characteristics of the goods and industries in the rest of the U.S. economy. We performed a major analysis of DOD procurement to prepare a firm foundation for any estimates of potential savings resulting from an ARPA-sponsored research and development program in computer-based manufacturing systems. Most of the detailed results of this analysis are contained in Appendix D. This section summarizes the most important issues raised by our analysis.

Issue 1: The purchasing power of DOD's procurement budget is declining.

The budget of the Department of Defense can be considered as comprising two major components: discretionary funds (such as procurement[1]) over which DOD has yearly budgetary control, and nondiscretionary funds (such as personnel salaries) over which there is little immediate control. Figure 1 shows the breakdown of DOD's budget for fiscal year 1972 into these categories and their major subcomponents.

During the past 10 years, the portion of DOD's budget allocated to procurement has declined:

1) as a percentage of the DOD budget (-10%);

2) as a percentage of the Federal budget (-7.4%);

3) as a percentage of the GNP (-1.3%).

If inflationary effects are considered, *the real purchasing power of DOD's procurement budget during the last decade has declined 26%.* (See Appendix D, Tables D-1 through D-7.)

• Conclusion 1: It is vital that DOD obtain more value per procurement dollar.

Issue 2: DOD procurement is characterized by relatively small quantities of sophisticated items, manufactured primarily by batch production methods.

Figure 2 shows a breakdown of DOD procurement by number of major end-items purchased. On one hand, it understates actual production quantities of subcomponents, since there is some duplication of parts; on the other hand, the procurement budget does not take into account the significant DOD expenditures for research, development, test, and evaluation (R,D,T&E)

[1] The procurement appropriations of DOD finance the acquisition of capital equipment, such as aircraft, missiles, ships, combat vehicles, weapons, torpedoes, munitions, and communications; major items for support of the capital equipment when it is in use; the industrial facilities necessary to produce that equipment; and major modification of equipment in inventory where modernization can be achieved without buying new equipment.

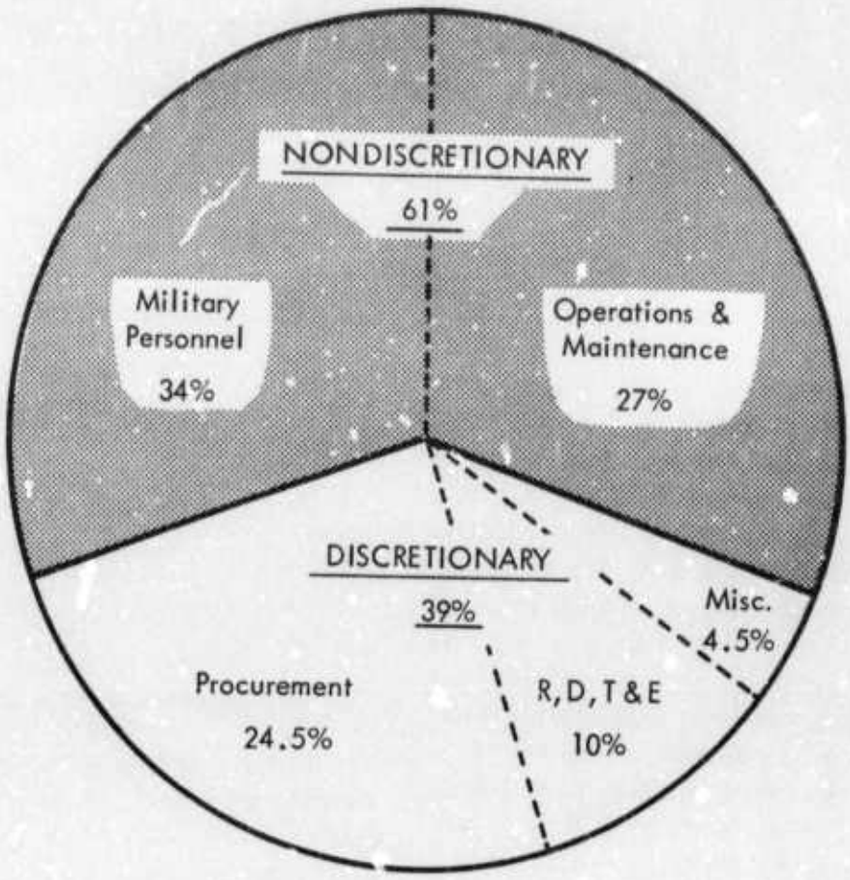

Figure 1. DOD budget FY1972. Total budget FY1972 = $76.7 billion. Source: The Budget of the U.S. Government, FY1972.

in which large sums are spent on the construction of prototypes in very small quantities. (Note that the data in Figure 2 accounts for $9.1 billion of the FY1973 DOD procurement budget of $19.3 billion; other procurement expenditures in the Five-Year Defense Program (FYDP) did not specify the quantity of items procured.)

The low production quantities shown in Figure 2 dictate the use of batch production methods by most major DOD suppliers and their subcontractors. (See Anderson[2] for a discussion of the distinction among batch production, mass production, and process control manufacturing methods.)

[2] Robert H. Anderson, *Programmable Automation: The Future of Computers in Manufacturing*, USC/Information Sciences Institute, ISI/RR-73-2, March 1973.

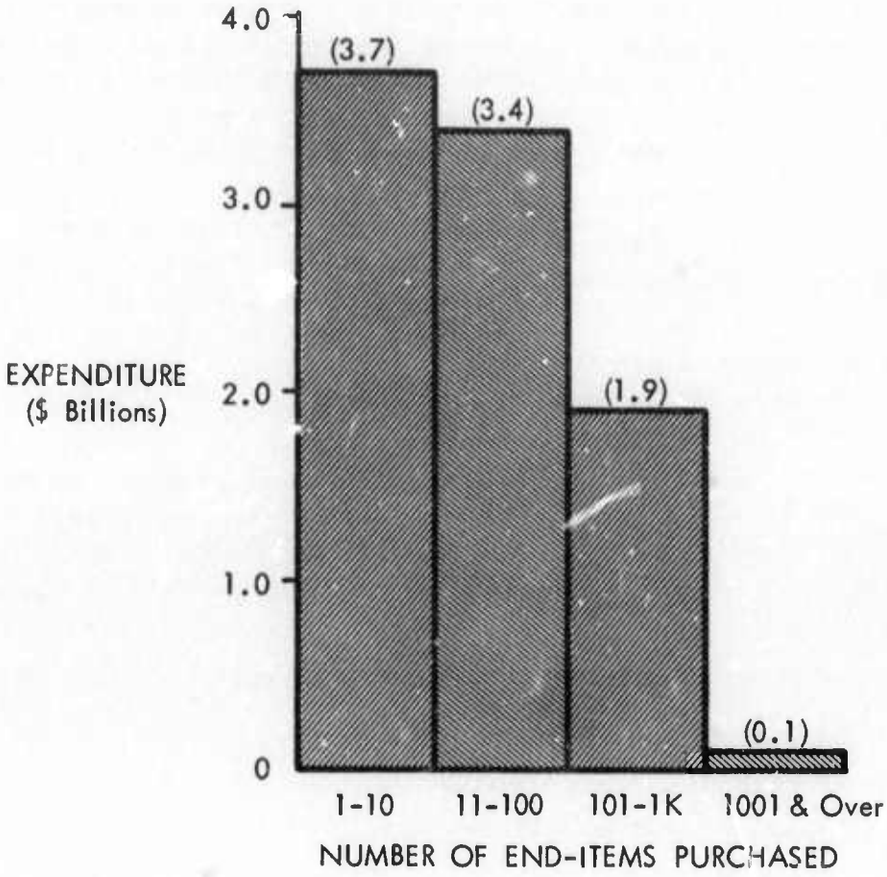

Figure 2. DOD procurement by number of major end-items purchased. Source: Procurement Annex, Five Year Defense Program (FYDP).

These low production quantities are not, of course, as characteristic of goods manufactured for the commercial market; the largest U.S. industry is motor vehicles and parts ($40,824 million, 1970 value of shipments), which mass produces and is larger than the total of aircraft ($10,996 million), aircraft engines and engine parts ($5,150 million), and electronic communications and avionic equipment ($9,331 million).[3]

It should be noted that the most successful example of past DOD sponsorship of

[3] U.S. Bureau of the Census, *Annual Survey of Manufacturers 1970 Industry Profiles*, M70(AS)-10, 1972.

manufacturing technology, namely numerically-controlled machine tools[4], was aimed explicitly at batch production techniques.

- Conclusion 2: Developmental programs aimed at increasing the productivity of DOD suppliers should concentrate on the batch production manufacturing environment.

Issue 3: DOD procurement is heavily concentrated in a few major industrial categories.

Table 1 summarizes major DOD procurements by program. (See Appendix D, Table D-8 for a more detailed breakdown.) Aircraft and missiles alone account for over 50% of DOD procurement; with ships they account for over 75% of procurement.

[4] Jack Rosenberg, *A History of Numerical Control 1949-1972 The Technical Development, Transfer to Industry, and Assimilation*, USC/Information Sciences Institute, ISI/RR-73-3, in progress.

The U.S. Department of Commerce categorizes all U.S. industry according to a system of Standard Industrial Classification (SIC) codes. The SIC system is used by all Federal statistical agencies, by most state agencies, and many private organizations. The SIC is an industrial classification of the total economy. It divides all activities into broad industrial divisions (manufacturing, mining, retail, agriculture, etc.). It further subdivides each division into industrial groups, and finally into detailed industries. For example, SIC code 37 comprises manufacturers of transportation equipment; within that group, SIC code 3722 comprises "establishments primarily engaged in manufacturing aircraft engines, complete missile or space vehicle engines and/or propulsion units and their parts". Appendix B contains the descriptions of SIC codes to a four-digit

Table 1

SUMMARY OF DOD MAJOR PROCUREMENT PROGRAMS
1971-1973

Program	1971	%	1972e	%	1973e	%
Aircraft	6.3	35	6.6	35	5.9	31
Missiles	3.3	19	3.4	18	3.7	19
Ships	2.3	13	3.0	16	3.6	19
Other	5.9	33	5.9	31	6.1	32
Total	17.8	100	18.9	100	19.3	100

e = estimated (in $ billion)

Source: The Budget of the United States, 1973 Appendix, p. 296.

breakdown. Another way, then, of categorizing DOD procurement is by the SIC codes of suppliers. Table 2 summarizes the data contained in Appendix D, Tables D-9 through D-12, and shows the three most important industrial categories to be: transportation equipment (44% of DOD procurement); electrical equipment (24%); and ordnance, including missiles, (22%). The two dominant subcategories within each major category are also listed. Again, the aircraft, missile, and related electronic equipment industries predominate.

- Conclusion 3: Proposed defense productivity enhancement techniques should directly address problems in the aerospace industries and their suppliers, with a product mix characterized by: (1) precise, high performance, costly materials and assembly processes, and (2) electronic-based subsystems.

Issue 4: DOD procurement is heavily dominated by a few corporations.

Table 3 shows the top 10 DOD contractors for FY1972. The prime contracts which they control account for 35.1% of all DOD procurement. The top 100 contractors have prime contracts accounting for 72.1% of DOD procurement, and the amount of contract award concentration in the top 100 contractors is increasing. (See Appendix D, Tables D-13 through D-16.)

Again, the history of the transfer of numerical control technology (see Rosenberg, op. cit.) to industry emphasizes the unique role DOD can play in sponsoring new manufacturing technologies, due to the unusually concentrated control it has over its suppliers.

- Conclusion 4:

1) It is possible for DOD to have a substantial amount of contractual leverage in promoting the transfer and adoption of new manufacturing techniques;

2) any proposed productivity enhancement program should directly address the needs of these important suppliers and their subcontractors.

Issue 5: The industry cost and labor structure for major DOD suppliers is significantly different from other types of industries.

Table 4 compares the labor breakdown in the aircraft and parts industry and the electronic equipment industry (both important DOD suppliers) with automobile manufacturers[5]. It shows that the ratio of administrative, clerical, and sales[6] employees per production worker is three times more for aircraft and parts manufacturers than for automobile manufacturers. (Data from another source [see Appendix D, Table D-26] shows over one-fifth of all employees in aircraft industries to be managers, administrators, and clerical workers.)

There are certainly many complex reasons for the variance in labor breakdown between the aerospace and automotive industries: the unique reporting and documentation requirements of government contractors; greater testing and inspection requirements

[5] The data in Table 4 is extracted from a detailed labor input-output analysis we have performed based on data for years 1958, 1963, 1967, and 1970; additional summary data from this analysis is contained in Appendix D, Tables D-17 through D-25.

[6] "Administration, clerical, and sales" is a U.S. Department of Commerce term encompassing managers, accountants, lawyers, librarians, editors, purchasing agents, bookkeepers, estimators, office machine operators, secretaries, shipping and receiving clerks, stock clerks, and personnel performing similar functions.

Table 2

DOD PROCUREMENT BY SIC INDUSTRY CODE, 1970
(Top 3 SIC Codes, With Their Top 2 Subcategories)

SIC	Value of Shipments to DOD ($ million)	(Value of Shipments to DOD)/ (Total Value of Shipments to DOD from all Industries) %	(Value added to Shipments to DOD)/ (Total Value of Shipments to DOD from all Industries) %
37 Transportation	12,169	43.9	21.7
3721 aircraft	6,299	22.7	10.1
3722 a/c parts & engines	1,579	5.7	4.5
36 Electrical Equip.	6,542	23.6	10.0
3662 radio & TV	5,631	20.3	9.0
3679 comm. equip.			
3679 electronic components	180	0.6	0.2
19 Ordnar	6,066	21.9	11.9
1925 guided missiles	2,546	9.2	6.0
1929 ammunition	2,283	8.2	3.4

Source: Department of Commerce, Annual Survey of Manufacturers, 1970; Shipments of Defense-Oriented Industries. Value added to DOD shipments computed by the ratio of DOD labor inputs to total labor inputs in that particular SIC times the value added for the ertire SIC.

Table 3

THE TOP TEN DOD CONTRACTORS FOR FY 1972
(IN DOLLAR VOLUME OF PRIME CONTRACTS)

	Company	DOD Contracts*	% of Total
1	Lockheed	1.7	5.1
2)	McDonnell Douglas	1.7	5.1
3)	General Dynamics	1.3	3.9
4)	General Electric	1.2	3.7
5)	Boeing	1.2	3.5
6)	American Telephone	1.1	3.4
7)	Grumman Corporation	1.1	3.4
8)	United Aircraft	0.9	2.9
9)	North American Rockwell	0.7	2.1
10)	Hughes Aircraft	0.7	2.0
	Total	11.6	35.1%

*(in $ billion). These figures are rounded.

Source: "100 Companies Receiving the Largest Dollar Volume of Prime Contract Awards", DOD (OASD) Directorate for Information Operations.

Table 4

COMPARATIVE LABOR BREAKDOWNS IN THE AUTOMOTIVE, AEROSPACE, AND ELECTRONIC INDUSTRIES (1970)

	% Motor Vehicles & Parts	% Aircraft & Parts	% Radio & TV Communications Equipment & Electronics
Non-praductian employees			
- R&D and other technical	7	19	18
- Admin., clerical, sales	12	25	21
Totals	19%	44%	39%
Production employees			
- Machining	11	16	3
- Assembly	30	9	42
- All other	40	31	16
Totals	81%	56%	61%
a) Total employment in listed industry	720,200	644,900	990,200
b) Total employment created in all industries*	1,793,300	1,102,800	1,683,300
Ratia af b) to a)	2.5	1.7	1.7

*Total employment created in all industries is estimated using productivity changes and input-output data on interindustry transactions.

Source: Census of Manufacturers, U.S. Department of Commerce.

in aerospace work; batch production versus mass production manufacturing methods. The point is not that one industry is better or worse than another, but that there are basic differences which should be taken into consideration.

- Conclusion 5:

1) The unique characteristics of DOD suppliers require a productivity-oriented development program tailored to their needs;

2) two major high-cost areas which should be explicitly considered are:

i) management, administrative, and clerical functions in the aircraft industries (one-fifth of all labor in these industries) [7]; and

ii) assembly in the electronic component and subsystem manufacturing industries (42% of all labor in these industries).

Issue 6: The interdependencies among the major DOD suppliers are significantly different from other sets of industries.

The relationships among the major DOD-related industries were derived from the input-output matrix of transactions compiled by the U.S. Department of Commerce for the entire U.S. economy; the inverse of the I/O matrix was used to find the input requirements of each major DOD industry from each other major related industry. This analysis was done for 1958, 1963, and 1966 to monitor the concentration of these industries.

[7] The importance of the management, administrative, and clerical function is, of course, greater than just the amount of labor devoted to this activity; operational decisions made by this sector have a great effect on the utilization of resources, level of inventories, and other functions which affect manufacturing productivity.

The results of these analyses (see Appendix D, Table D-27) indicate a high degree of interdependency of the four major DOD-related industries (ordnance, aircraft and parts, radio & TV equipment, and avionics). Each industry relies upon itself and the other three for 52%-66% of all the inputs needed for production.

- Conclusion 6:

1) A productivity improvement in one of the major DOD-related industries can enhance the ultimate productivity in other major DOD-related industries due to the high degree of subcontracting within this set of industries;

2) if a new technology is introduced in one industry, it may also be necessary for the others to adopt it (or a variation of it) to maintain current trading patterns.

Issue 7: DOD-related industries hold relatively large and expensive inventories.

The value of inventories for all manufacturing groups at the end of 1967 amounted to $84.4 billion. The major DOD-related industries (e.g., aircraft and parts, ships, and communications equipment) are among those with exeptionally high inventory costs; most of these costs are "work in process" and "materials", in contrast to "finished goods" which are subject to external demand factors.

A breakdown of the inventory on hand at the end of 1967 by SIC code is found in Table 5. Column 7 contains the relation between inventories on hand and shipments. The average for manufacturing is about 15%, but every defense-oriented industry (with the sole exception of ordnance,

Table 5

VALUE OF MANUFACTURING INVENTORIES FOR DOD-RELATED INDUSTRIES (1967)
(in $ million)

SIC	Industry	Value of Inventory, Total	Ratio of Inventory to Shipments col.(2)/col.(4)	Total Shipments	% of Col.(4) Shipped to DOD	Approx. DOD Share of Inventory	Approx. Inv. Cost to DOD/Year*
(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
19	Ordnance	1,314	.142	9,267	62.0%	815	81.5
1925	Guided Missiles	485	.105	4,640	55.1	267	26.7
34	Fabricated Metal Products	5,644	.164	34,578	1.1	621	62.1
35	Machinery (not electrical)	10,917	.225	48,477	2.8	3,057	305.7
365	Radio & TV Equipment	765	.186	4,123	0.0	-0-	-0-
366	Communication Equipment	2,651	.238	11,147	48.6	1,288	128.8
367	Electronic Components	1,286	.173	7,452	8.3	107	10.7
371	Motor Vehicle	3,527	.087	40,340	0.2	7	.7
372	Aircraft & Parts	7,277	.345	21,064	58.9	4,286	
373	Ships & Boat Building	916	.295	3,090	37.7	345	34.5
	All Manufacturing	$84,405	.151	557,398	5.6%	$10,165	$1,016.5

*Assuming a 10% carrying charge for inventory.

Source: Department of Commerce, Annual Survey of Manufacturers: 1970, June 1972; and Shipments of Defense-Oriented Industries: 1967, August 1969.

SIC 19) held a larger portion of their shipments in inventory. Selected nondefense-oriented industries (motor vehicle manufacturing (SIC 371) and fabricated metal products (SIC 34)) were used for comparison. Motor vehicle manufacture was just over half the average (at about 9%) while fabricated metal products were slightly above average (at 16%), but below all defense-related SICs except 19. Aircraft's (SIC 372) high ratio of inventory to sales (35%) is more than twice the total manufacturing average.

Translating the inventory figures into potential cost savings from computer-based manufacturing systems can be done by applying a conservative 10% inventory carrying cost. This cost represents the cost of borrowing funds to finance the inventory (or conversely, the opportunity cost of not having to finance it), insurance, storage, theft and breakage, and taxes. If we assume that the ending inventory is the yearly average, annual inventory holding costs would be $8.4 billion a year for all manufacturing firms. For major DOD-related industries alone the yearly inventory costs are about $1 billion; the ratio of inventory to shipments in these industries is more than twice the average for all manufacturing. (See Appendix D, Tables D-28 and D-29.)

- Conclusion 7: Computer-based aids to manufacturing which reduce inventories can substantially reduce the costs of many DOD-related products.

Issue 8: Productivity enhancement of DOD-related industries is significant to U.S. competitiveness.

The U.S. experienced an unfavorable balance of payments (trade plus capital flow) of $9.24 billion in 1972. In spite of recent improvements, a major 1973 balance of payments deficit is still predicted by economists. Of the total deficit, trade alone will account for from $4 to $5 billion.

An analysis of U.S. trade revealed that both exports and imports of manufactured products are very significant -- 70% and 65% of the total, respectively. However, for the period 1965-1971, imports of manufactured goods increased 173% versus 78% for exports. The significance of these differential rates of growth is that the U.S. favorable trade position in manufactured goods dropped from $6.2 billion to zero from 1965 to 1971. In the fourth quarter of 1971, the U.S. share of the world's total manufactured exports dropped to 17.6% compared with 22.8% in the fourth quarter of 1968. This drop was evidenced in most major categories of manufacturing[8].

Slower rates of productivity increase in the U.S. compared with its major competitors are one of the major causes of reduction of U.S. international competitiveness. The U.S. labor productivity rate of growth has been half as much during 1965-1971 as in 1950-1965. The rate of productivity gain in Japan equaled six times the U.S. rate between 1965-1971.

The trade trends from 1960 to 1972 shown in Figure 3 point to a long-term deterioration of the U.S. trade balance. (See Appendix D, Table D-30.) However, the data in Figure 3 shows a favorable balance of trade in DOD-oriented industries. On the

[8] Nabil M. Kamrany, "Background Data on U.S. Productivity and Foreign Trade", submitted to the NSF Conference *National Inquiry into Productivity in the Durable Goods Industry*, October 4-6, 1972. Also reprinted in the American Automatic Control Council, *Automation Research Council Proceedings*, November 30 - December 1, 1972.

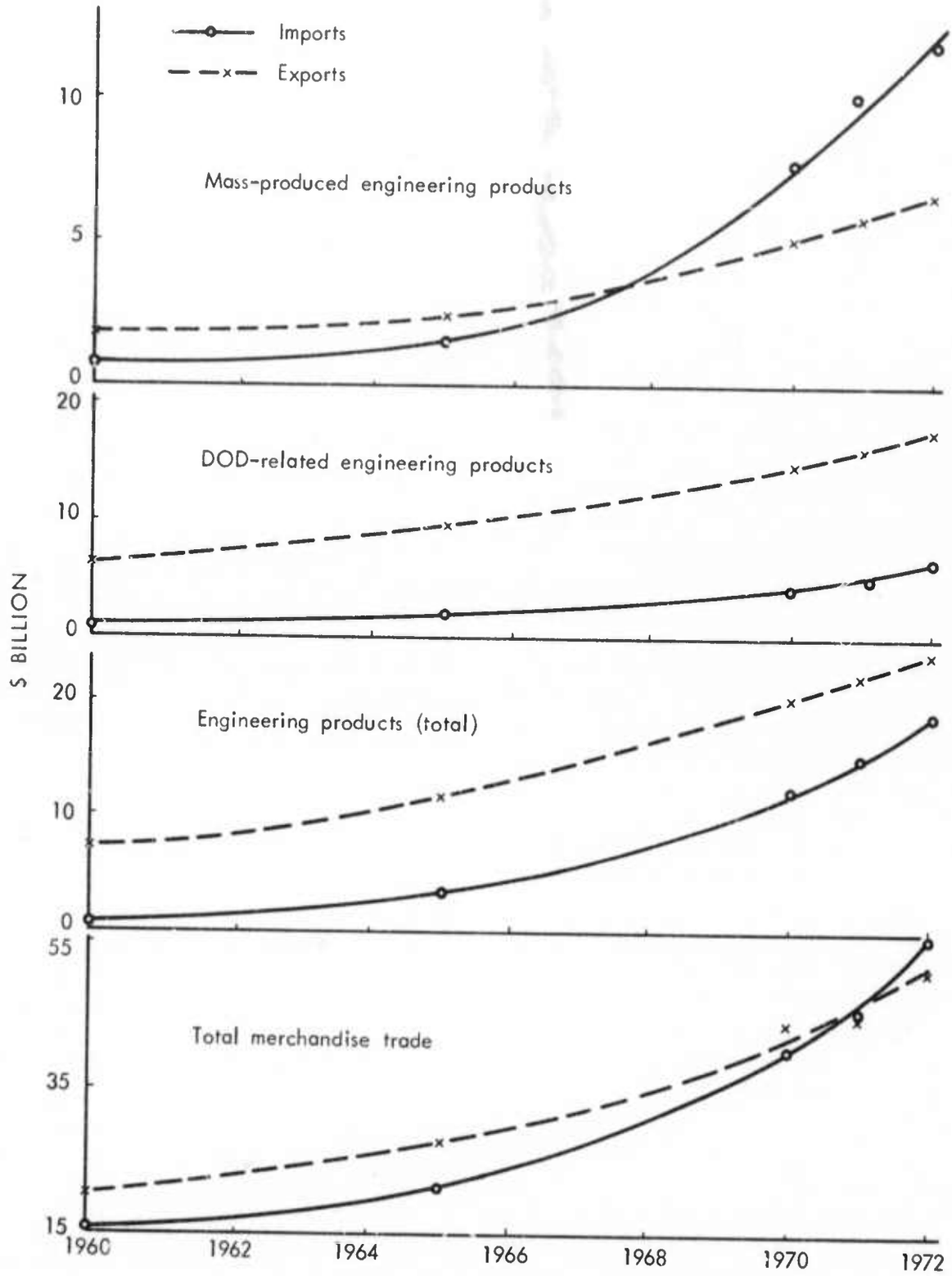

Figure 3. Trends in U.S. merchandise trade.

other hand, mass-produced goods have lost out to foreign competition. It is thus clear that the U.S. enjoys comparative advantage in such industries as missiles (SIC 1925), aircraft parts (SIC 3729), and most engineering products (SIC 35-38), excluding automobiles and equipment, household appliances, radio, TV, and phonographic and sound reproduction equipment. A recent study points to a high correlation between exports and R & D expenditures, as shown in Table 6.

However, the growth of imports of these products, more than twice as rapid as that of exports (1960-1972), implies that even in these industries the U.S. is losing the advantage (see Appendix D, Table D-30).

- Conclusion 8: Productivity enhancements in DOD-related industries through R & D are crucial to the U.S. balance of payments.

Table 6

Industries	% of Group of 10 Exporting Countries-1969	Engaged in R&D as a Percentage of Employment
Aircraft	62.45	7.68
Office machinery	37.33	6.66
Other machinery	26.30	1.06

Source: Keesing, D. B., "The Impact of Research and Development on United States Trade", Journal of Political Economy, February 1967.

III. HOW DISCRETE PRODUCTS FOR DOD ARE NOW MANUFACTURED

The preceding section considered the composition of DOD procurement as depicted by summary statistics gathered primarily by DOD and the U.S. Department of Commerce. Such statistical breakdowns are useful in pinpointing general categories of importance, such as "management, administrative, and clerical", and assembly of electronic-based products; however, improvements to these categories cannot be considered in isolation. The manufacturing enterprise is a complex system, and the interrelationships among the various components must be considered in recommending significant changes to this system.

To understand the system aspects of the batch manufacture of DOD-related products, we inspected many different manufacturing facilities; of these, we selected three particular facilities as representative of many of the varied job shop environments of importance in the manufacture of DOD products. We performed rather detailed case studies of these three manufacturing environments, with the active cooperation of the line managers responsible for production. The facilities studied are:

- TOW Missile Production at Tucson Division, Hughes Aircraft Company, Tucson, Arizona
- The manufacture of a simple precision gearbox at Precision Products Division, Western Gear Corporation, Lynwood, California
- The Numerical Control Fabrication Facility at Douglas Aircraft Company, Torrance, California

In each study, we examined a variety of possible computer-based system innovations which might have a significant impact on productivity, from near-total programmable automation of the manufacturing process to incremental enhancements of existing machines or control processes. Each of these case studies is discussed below, together with our conclusions about the potential impact of advanced, computer-based manufacturing systems on the production of these products.

A. TOW Missile Production

CASE STUDY - Tuscon Division, Hughes Aircraft Company

Due to the widespread use of electronic packages in products procured by DOD, we felt it was important to study the manufacture of a product having an electronic module. After examining several possible candidates, the Army's TOW (*T*ube-launched, *O*ptically-tracked, *W*ire-guided) missile, manufactured by the Tuscon Division of Hughes Aircraft Company, was picked as

being representative of a large class of electronic-based military products.

The primary objective of this case study was to estimate the potential for hardware automation equipment developments which might have a major impact on manufacturing productivity for this important class of products.

1. The Product and Its History. The Tuscon Division considers its mission to be "production of advanced-technology military guided weapons". During the past two decades, it has made over 40,000 Falcon (air-to-air) missiles and over 30,000 TOW missiles. In addition to the TOW, it is currently producing the Navy's Phoenix missile and the Air Force's Maverick missile. At the time this manufacturing facility was studied in October 1971, employment was about 2,500; it has been as high as 5,800.

The first test firing of an "advanced development model" of TOW occurred in March 1965. The product was defined in Army-format drawings in June 1966. The first production contract was awarded in June 1968; first production deliveries were made in August 1969. TOWs were in normal production at Tuscon starting about July 1970. In October 1971, they were being produced at a rate of about 600/month; recently, the rate has been 1,500/month.

Some relevant data concerning TOW production:

- The Tuscon plant is "GOCO" -- *G*overnment *O*wned *C*ontractor *O*perated. There are about one million square feet of plant space on four square miles. An informal estimate of the replacement cost of the plant and tools is $200 million. About 40% of the facility is devoted to TOW manufacture. About 60% of the equipment in the facility is Government-owned, the remaining 40% is Hughes-owned.

- Engineering changes are a significant item. During the production engineering phase (1966-1968), about 34 engineering change analyses were made each month; each analysis defines a real problem and its engineering solution and cost. It may affect several different production drawings. By the end of 1971, after about 18 months of normal production, there were still about 15 analyses/month performed, and these resulted in about 8 formal engineering change proposals *per month* -- requiring the approval of the Army Contracting Officer, because the change would affect the form, fit, function, or contract price of the product.

- Rework costs can be significant. The most common cause is failure of electronic components, especially during vibration tests. The failure rate of the TOW electronic package during production is between 3%-10%. (Only packages that eventually pass all tests, of course, are assembled into the missile. After passing all such tests, the reliability of the TOW end-product has been notable.) On a much more sophisticated missile such as Phoenix, about 30% of the labor is involved in rework during early production phases.

- In October 1971, at a production rate of about 600/month, the unit price of a TOW missile was above $3,500. This was on a one-year contract. Currently, Hughes has a four-year guaranteed procurement contract; at the current production rate of 1,500/month, the average unit price (including G&A and profit) is about $2,200. Major

sources of these savings have been significantly lower negotiated prices from suppliers, due to the four-year procurement potential, and a number of *C*ost *R*eduction *P*roposals (CRPs) submitted by Hughes to change manufacturing methods (most often involving increased use of hard tooling).

2. Analysis of the Product. Because of the importance to DOD of the type of manufacturing operations involved in TOW production, we commissioned two studies of the product from SpectraVision, Inc., Santa Monica, California, a consulting firm specializing in advanced automation technology analysis. The studies were:

1) a detailed analysis of the assembly of the electronic unit in the forward section, and of the mechanical assembly operations required in the aft section of the missile; (these operations account for about one-third of the total assembly operations);

2) an estimate of the impact that total, flexible, computer-based automation would have on TOW production, if such automation were indeed technologically feasible.

The results of the first analysis are only summarized here, due to their proprietary nature. (Hughes must bid competitively for TOW contract awards.) They show approximately:

- 3 man-hours of electronic assembly (forward section), and
- 3/4 man-hour of mechanical assembly (aft section) per missile. (See illustrations of TOW missile components in Figure 4.) On this basis, we calculate about 12 man-hours of assembly operations per missile within the Hughes facility. At $12.50/hour, this accounts for about $150 of the production price, or about 22% of the value added by Hughes at the current price and production rate.

The second study performed by SpectraVision assumes nearly total, but flexible, computer-based automation of TOW manufacture. It assumes the concept (see Anderson, op. cit.) of a palletized, random access conveying system serving work stations, including programmable assembly machines:

> The "plant floor" might consist of a number of work stations, distributed in a convenient manner (perhaps grouped according to function -- part forming and machining, assembly, inspection, storage -- for ease of maintenance, cleanliness requirements, etc.). Each work station performs a manufacturing operation under direct computer control, and is serviced by a computer-controlled "random-access" conveying mechanism. The interface between the conveying system (which would have limited degrees of freedom and coarse positional accuracy) and a work station (perhaps requiring rather precise orientation and positioning of tools and in-process materials) might well be handled by an industrial robot with some limited sensory feedback capabilities. One robot would normally provide the I/O interface for a group of several work stations, since the processing time at a work station tends to be long relative to the I/O time.

The detailed assumptions upon which the analysis is based, and the results of that study are contained in Appendix E. In summary, the principal assumptions made are:

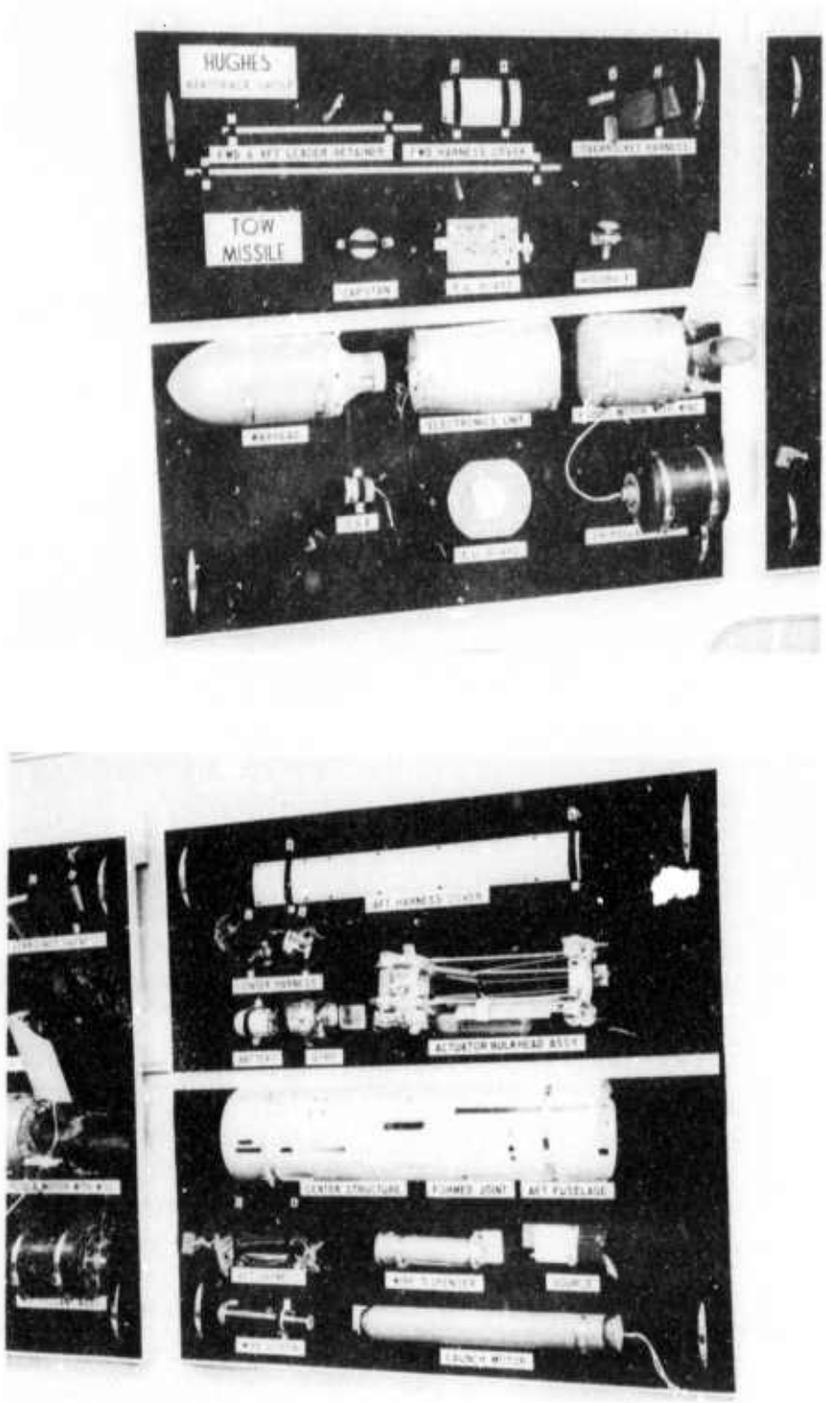

Figure 4. TOW missile components

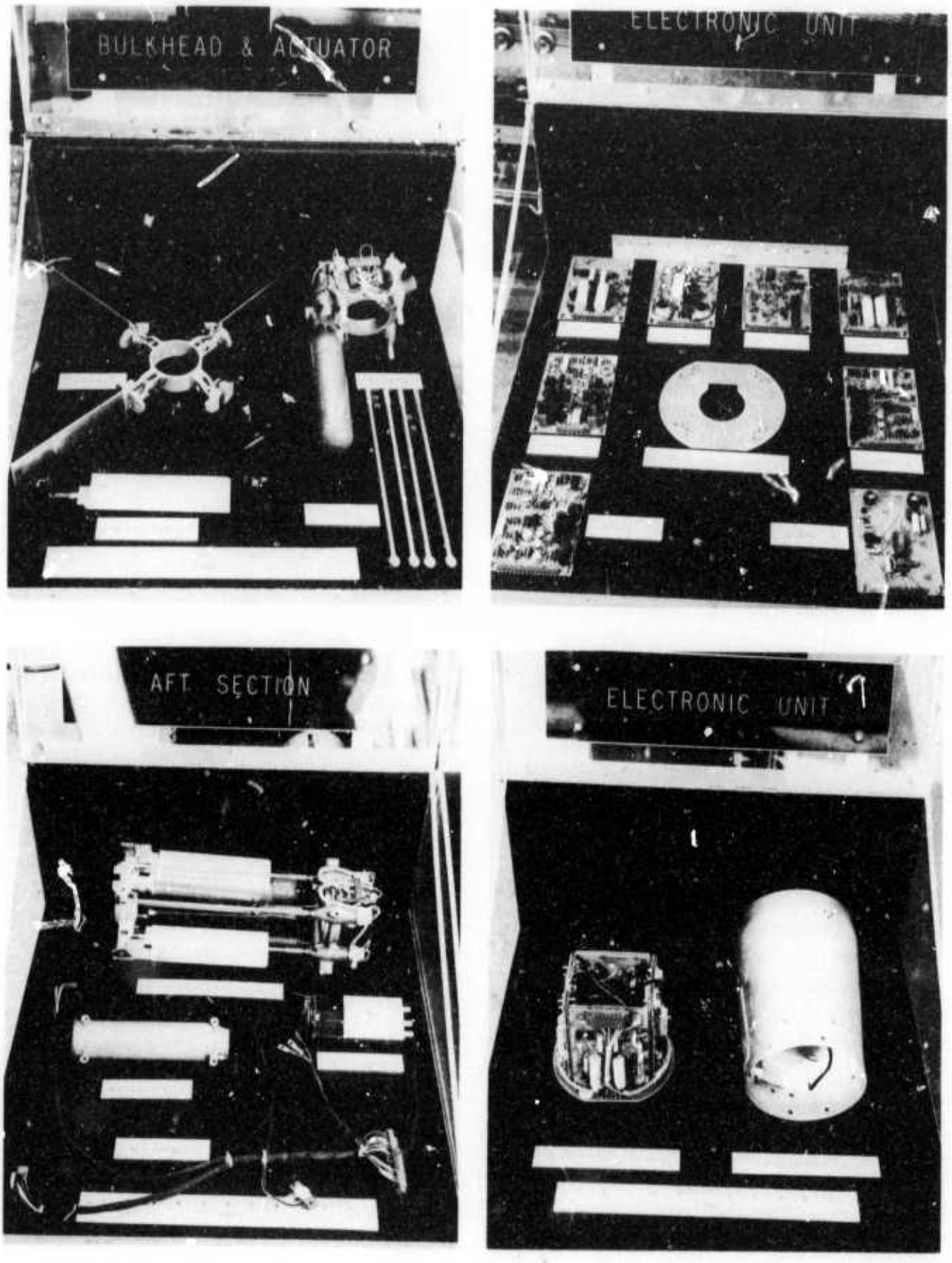

Figure 4, cont'd. TOW missile components

- a production rate of 600 missiles/month;
- manufacturing and assembly process steps and sequence very nearly the same as those performed manually at present;
- separate machines for board stuffing, wire wrapping, coil winding, environmental testing, etc.;
- one programmable assembly machine capable of performing essentially all mechanical assemblies and most of the electrical and mechanical testing;
- a 20-man programmer/planning staff; a 13-man maintenance and repair crew, plus managers, secretaries, purchasing agents, source inspectors, etc.;

and the principal results reported are:

- a total of only $300 in costs added per missile by the Hughes facility (assuming 60% Government ownership of tools, as is currently the case);
- a total of only $11+ million for capital investment (excluding R & D) for such a plant;
- 51% spare capacity potentially utilizable for other production purposes.

Programmable assembly machines of the type hypothesized do not exist today, nor does a palletized conveying system that could handle the shapes and sizes of the thousands of different parts and subassemblies during the manufacturing process.

The degree to which such an automatic factory is capable of reducing total manufacturing costs is significantly affected by the fraction of the total cost that is purchased parts, subassemblies, and subcontracts. Cost reduction is also a function of the degree of automation that vendors and subcontractors employ. In the TOW study (600/month rate), with nonautomated vendors who presently receive 57% of the total cost the reduction in *value added* (by Hughes) was to about one-fifth of the former value, whereas the reduction in *total manufacturing cost* was estimated at 34%. Assuming that all subassembly vendors (e.g., suppliers of gyros, batteries, actuators, etc. -- but not basic materials suppliers) were automated, an estimated total manufacturing cost improvement of 57% would be provided.

3. Conclusions - TOW Missile Production. Based on our analysis of TOW and other electromechanical DOD procurement items, we made the following general observations:

- The continuing revolution in electronics (LSI, thin films, electron-beam etching, etc.) will not eliminate the assembly task in electronic packages. DOD's appetite for electronics seems to be constant volume, not constant function. When the space behind the warhead of a missile can hold an array computer, it probably will. The fact that a single chip will perform the functions of an entire circuit board will only lead to more complex designs involving many such chips. The space is there, and the increased functions can usually be justified.
- The electronics revolution does not have a rapid effect on the production of military weapons systems. The design of the TOW, for example, was basically frozen in 1965, when the first prototype flew. Successful designs, having undergone elaborate testing and validation, are not usually changed in such fundamental ways as revamping the electronics based on next-generation possibilities. The discrete component circuit

boards in the TOW will be around in it and in similar products for many more years.

- Many of the subassembly tasks involved in the electronic and "light source" units seem potentially automatable, and they seem to absorb a disproportionate amount of assembly labor at present (about one-third of total assembly labor). The assembly operations required for such subassemblies are the most promising we have seen for the initial application of programmable assembly machine techniques.

B. Western Gear Corporation

CASE STUDY - Manufacturing Department, Precision Products Division, Lynwood, California

Western Gear Corporation is the largest independent manufacturer on the West Coast of such precision mechanical products as gearboxes and actuators. Almost every DOD prime contractor manufacturing aircraft, ships, or missiles subcontracts to Western Gear.

The Precision Products Division at Torrance, California, is an excellent example of a job shop; at any specific time, about 3,000 diverse Manufacturing Orders (MOs) are in process. Our case study focused on two aspects of manufacturing at Western Gear:

- the detailed processes involved in their manufacture of one specific gearbox;
- the system by which a manager allocates and controls manufacturing resources and jobs in this complex job shop environment.

1. The Product and Its History. We asked the Manufacturing Manager to select the simplest gearbox they make for DOD end use. We requested and received access to information on the scheduling, fabrication, assembly, and support services necessary to manufacture this box.

The gearbox chosen by Western Gear is shown in Figure 5; four of them are used by Lockheed in each C-130 aircraft. Lockheed first ordered this box in 1957, at which time Western Gear received a contract to build and test a small number of boxes for compliance with rigid military specifications. The design and processes met the specifications and the product was fully qualified. Since then, Western Gear has received a repeat order for this item about once per year. Typical cycle time from receipt of a purchase order until completion of shipment is 12 to 15 months. In August 1971, Lockheed placed an order for 150 boxes at a unit price of about $2,000 with a requested delivery rate of about 10 per month. This low rate would have been too costly, so Western Gear scheduled the order as follows:

- Materials were purchased for one lot of 150 boxes, with allowances for shrinkage based on the long history. (This long history is a useful but unusual situation.)
- Fabrication operations which required a long setup time, such as metal cutting, heat treating, and plating, were handled as a single batch of 150.
- Operations such as deburring, assembly, testing, painting, labeling, and inspection, were performed in batches of about 50 during each of three consecutive months.

During October 1972, 54 boxes were completed and shipped, bringing the delivered total to 103. The remaining 47 units

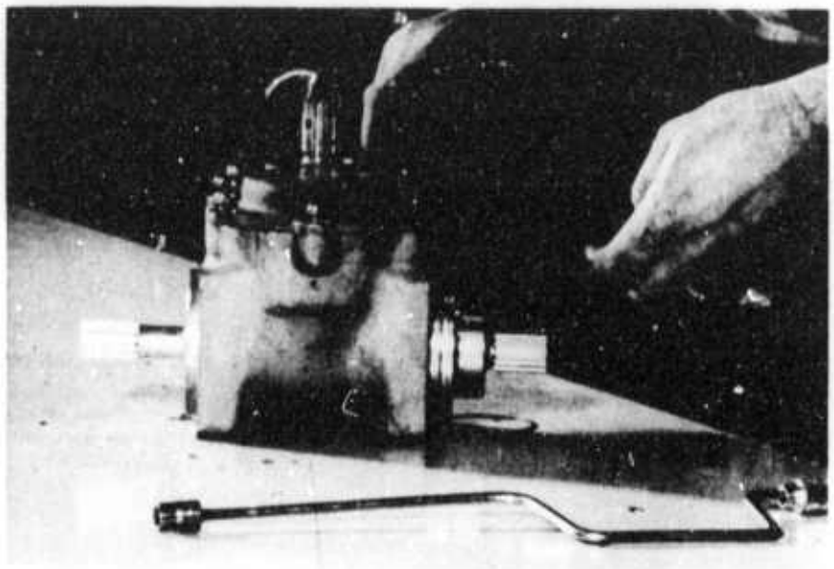

Figure 5. Gearbox manufactured by Western Gear Corporation for Lockheed C-130 aircraft.

were assembled and shipped in November 1972.

a. Components. Each box contains the following 12 major components, each of which is fabricated by Western Gear from materials purchased outside:

QUANTITY	PART DESCRIPTION
1	Housing - Main
1	Cover - Housing
1	Retainer - Bearing
1	Shaft - Input
2	Liner - Bearing
1	Sleeve - Bearing
1	Gear - Bevel
1	Adapter - Bearing
1	Gear - Output
1	Gear - Intermediate Spur
1	Spacer - Bearing

There are also 96 minor components, for a total of 108. Eleven of those 96 are fabricated by Western Gear; 85 are purchased outside already fabricated. We performed

our operation and cost analysis on the 12 major components, based on the Manufacturing Order for each part. (An MO is prepared by the Production Control section of Material Control as the authorization and complete bible for the manufacture of each part made internally by Western Gear; see Section III.B.2 below for a discussion of the organization of the Manufacturing Department. A sample MO for the main housing of this gearbox, the Engineering Parts List, and the final Assembly Inspection Record form are contained in Appendix F.)

b. Manufacturing Operations. All the operations indicated on the 11 MOs are performed in a total of 17 different shop departments. About 26 man-hours of direct labor are required per gearbox, of which about 75% is involved in direct operations, and 25% is involved in setup. The percentage breakdown of direct operation labor cost, by department, is shown in Table 7.

The percentage breakdown of setup labor cost, by department, is shown in Table 8.

c. Observations and Conclusions. Perhaps the most significant statistic concerning the production of this simple gearbox is that *258 movements of parts between different locations are required.* (Since completion and shipment took place during 3 months as three batches, somewhat more than 258 moves were actually made.) Clearly, in a job shop environment, the control of in-process parts, tooling, and materials is a major consideration.

We inspected all of the departments involved in the above manufacturing steps, and discussed the operation with the Manufacturing Manager. The following are some of our major observations and the conclusions we have drawn:

- The relative manpower strengths in the shop departments are similar to the cost ratios we derived for the particular gearbox we studied; as the loading in departments varies with the mix of orders, management transfers men from a low to a high demand function. They select and train men to provide this flexibility. The operation in which our box was least representative of average products was final assembly. Most gearboxes contain five or ten times as many parts, which increases the demands on the assembler for dexterity, precision, and judgment. He is called on to use additional skills, not the same skills more often.

- There are so many uncontrollable and poorly predictable variables in the physical properties of metals that few gearboxes would meet the stringent DOD specifications without the continuous use of ingenuity by operators to beat the odds. When part fabrication operations have been automated (e.g., with numerically-controlled machine tools), the cost of the machines easily justifies the relatively small additional expense of a human operator to monitor the machine's performance; his reaction to malfunctions detected by subtle patterns of sight, sound, smell, and touch sensations can save tens of thousands of dollars and weeks of downtime.

- *Conclusion: Significant reductions in direct labor through automation are extremely unlikely in the manufacture of this and similar precise mechanical products manufactured to existing DOD*

Table 7

DIRECT OPERATIONS LABOR BREAKDOWN,
C-130 GEARBOX

Department Involved	% of Total Direct Operation Labor	# of Distinct Operations
Inspection	19	50
Small gear cutting	15	10
Grinding	14	44
Turning (rough)	13	19
(De)burring	10	17
N/C machining	7	9
Large bevel gear cutting	5.7	5
Heat treating	5.5	35
Assembly	4.6	4
Turning (fine)	4	11
Spindle drilling	1	4
Sawing	1	8
Milling	0.2	1
Totals	100.0%	217

Table 8

Department	% of Total Direct Setup Labor
Heat treat	51
Plating	20
Sawing	9
Turning (rough)	6
Total other [9]	14
	100%

[9] Casting stores (3%); grinding (2%); stores (2%); N/C machining (1.9%); turning - fine (1.7%); small gear cutting (1.6%); large bevel gear cutting (0.7%); inspection (0.6%); spindle drilling (0.3%); milling (0.2%).

specifications. The only hope for cost reduction through automation of existing manual operations for these products would seem to be a radically new design philosophy allowing very reliable, accurate products (such as airplanes and missiles) to be made from components whose specifications have considerable latitude; such a development is highly unlikely.

- An operator can usually meet or exceed the time standards for the setup and performance of each process if the material, tools, information, equipment, and conditions are on time and correct. It is not now possible for management to control all these factors and meet these criteria in at least half the cases; nearly all significant deviations from time standards can be traced to these causes.

•*Conclusion: The management and control of resources in a job shop environment is currently a major source of inefficiency; the investigation of computer-based real time production control systems to aid in the management of these resources in a job shop environment must have high priority.*

• During January 1973, at the time this study was performed, the Manufacturing Department had about 500 employees, and monthly billings were about $2,000,000. The overhead rate charged was 180%; of this, about 80% represented rent and other occupancy factors, fringe benefits, and equipment depreciation. The remaining 100% represented management and support services, i.e., people. *For each man performing a direct operation there was another person trying to keep him usefully employed.*

•*Conclusion: This case study again illustrates that overhead services for DOD-related manufacturing industries are a major cost factor.* (We derived the same conclusion from the comparative statistics for "administrative, clerical, and sales" labor in Section II.) We again conclude that computer-based management and engineering aids to increase the productivity and efficiency of indirect labor are of great potential importance.

2. Manufacturing Production Control. Due to the importance of production control in a job shop, we studied the systems and procedures by which such control is currently exercised. Before analyzing production control, however, it is important to understand the interrelationships among the Manufacturing Department and the other departments of the Precision Products Division; the information flow within the Division is the source of the data used by Production Control.

a. Information Flow Within the Division. When a customer (in the case of the gearbox, Lockheed) issues a purchase order to Western Gear, it is sent to the Sales Department. This department generates and distributes a Sales Order to Accounting, Engineering, Quality Control, and Manufacturing. The first time a product is ordered, Engineering prepares an Engineering Release, containing a Parts List (Bill of Materials), Prints (which include purchase specifications and inspection criteria), and Assembly Drawings. The Sales Order and Engineering Release are directed to Material Control and Industrial Engineering in the Manufacturing Department. Industrial Engineering does the planning and transmits the results to Material Control. The planning output contains material requisitions which go to Purchasing (under Material Control) for outside procurement. Planning also issues a list of fabrication and inspection steps for each part on the Parts List, tools and fixtures required at each step, and time standards for the setup and operation of each process.

The latter documents are sent to the Production Control section of Material Control. Production Control prepares, for each part that will be internally manufactured, a detailed MO form which is, as mentioned in Section III.B.1.a above, the authorization and complete instructions for the manufacture of the part. The MOs go to the Shop Superintendent, who implements and controls the manufacture of the component

parts, the final assembly, and final tests according to the MO plan.

Our analysis concentrated on the functions performed by Production Control, and how the services of the Corporate Computer Center were used by the Manufacturing Department.

b. The SCOPE Production Control System. The only use of corporate computers by the Manufacturing Department is a package called SCOPE (*S*cheduling by *C*omputer and *O*verall *P*roduction *E*valuation). It was developed by the Western Gear Corporation corporate computer center for use by Production Control.

SCOPE, like many other production control systems we have seen, is a batch system useful only for rough job scheduling and monitoring. The major input is an MO and its scheduled completion date, both prepared manually by Production Control. Its major outputs are:

- shop dispatch cards, one for each operation scheduled;
- semiweekly reports for Production Control, Accounting, the Manufacturing Manager, and several managers reporting to him.

Reporting of work accomplished is manual. Conflicts for resources and other problems which produce deviations from scheduled completion dates must be resolved manually. No useful exception reports are available.

Our analysis of the use of the SCOPE system produced the following observations:

- The Manufacturing Manager is charged $15,000 per month for the service; for that, he receives a pile of "tab runs" twice a week. The information is too voluminous to be used effectively.
- The Manufacturing Manager has come to believe that it is difficult to make small changes to the existing system to improve its accuracy or functional capability.
- The Manufacturing Department is required by corporate policy to purchase all programming and processing services from the computer center, and is not permitted to seek alternatives outside the company.
- The job shop environment is extremely dynamic; priorities change on a daily -- sometimes hourly -- basis. Management decisions are continually required, often based on data that is not available in any formal information system.
- Control of resources on an hourly basis is currently performed manually. Each morning the Manufacturing Manager prepares a new list of critical jobs and questions. From 7:00 A.M. to 8:30 A.M. he meets with key members of his staff to request the *accurate current* status of the jobs -- what has been completed, what is in process, what problems prevent the schedules from being met, and where every critical part is located. His subordinates are instructed to gather information by personally touring the shops, not just relying on the computer listings. As the reports are presented to him, the manager manually determines job priorities and gives orders for the rescheduling of personnel and equipment to overcome the critical problems. The manager spends the rest of each day following the progress of these items, trying to anticipate what future bottlenecks he created with

that day's decisions, and preparing instructions for the night shifts to correct deviations from his morning plans that occurred during the day due to unpredictable variables.

Conclusion: There is a requirement for real time industrial information and control systems that:

- are timely, accurate, and reliable;
- are flexible and modifiable;
- interface directly to managers having the responsibility for control;
- aid managers in predicting the consequences of actions and decisions.

To meet these requirements, a level of sophistication is required in real time, interactive software systems that is not currently available in an industrial environment.

C. Douglas Aircraft Company

CASE STUDY - N/C Fabrication Department, Torrance, California

1. Company and Department Products. The McDonnell-Douglas Aircraft Corporation builds commercial and military aircraft, missile, and space systems. The Douglas Aircraft Division manufactures commercial aircraft and components, and subsystems for similar military products. Although no system can be completed unless all its components have been assembled, the structural members are considered the most critical components. The N/C Fabrication Department in the Torrance, California, plant manufactures all the large and many small structural components for the DC-8, DC-9, and DC-10 commercial transports, and many major parts of the F-4A, F-15, and missile systems assembled in the McDonnell-St. Louis facility.

About 700 different types of parts are machined, finished, and inspected in this department. The sizes range up to dog-leg wing spars 30 feet long, and banjo fittings 16 feet long and 10 feet wide for the tail engine of the DC-10, both milled from aluminum forgings. (See Figure 6.) There are many small parts about the size of an office desk cut from forgings of high-tensile steel or titanium. A very few machine tool stations are dedicated to a single type of part -- one that requires a large number of machining hours. Most stations manufacture a variety of parts on a batch basis; the department is therefore operated as a large job shop.

The schedule for the final assembly of complete aircraft in Long Beach or St. Louis from complete ship sets of components controls all decisions in the N/C Fabrication Department. It is unforgivable for a $25 million DC-10 to sit unfinished because a part was not present at the final assembly location on time. Most of the nonstructural parts can be obtained from more than one source, but for most of the parts made by the N/C shop it is the only possible source. As a result, the eyes of the corporation are always focused on this Department, and an interruption in its output is not tolerated. Therefore, we were very interested in analyzing the procedures by which production control was managed, and the potentials of computer-based manufacturing systems for increasing productivity.

2. Resources of the Department. Nearly all structural parts of air and space vehicles are warped three-dimensional surfaces with

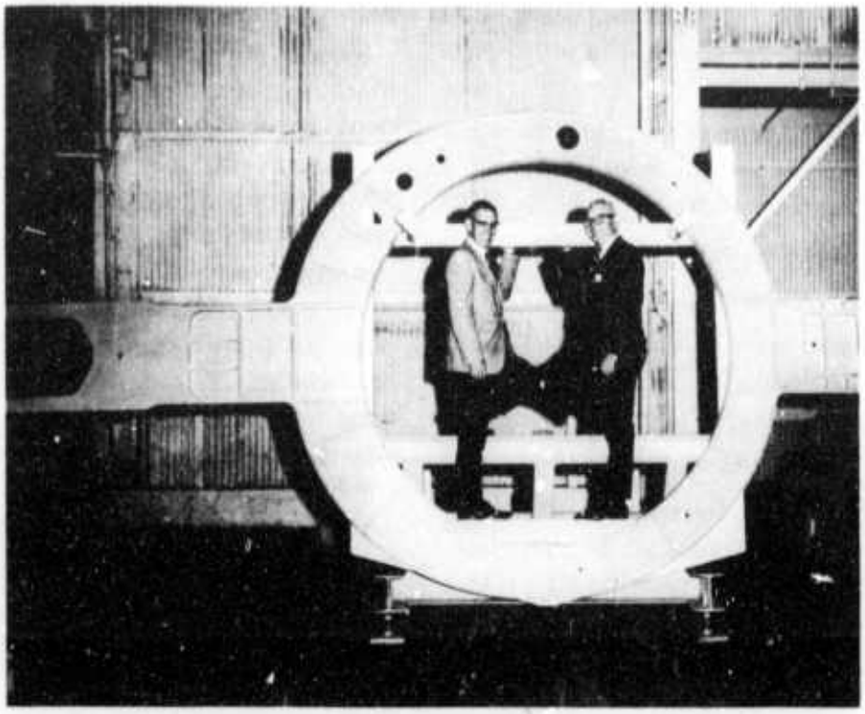

Figure 6. Machined "Banjo Fitting" for DC-10 aircraft.

no symmetry about any axis or plane. To machine accurately these contoured shapes from high-tensile metal with the fewest number of fixtures and machine setups requires large, rigid five-axis milling machines called profilers. At the present time, Torrance is the world's largest five-axis N/C facility. About 80 N/C tools costing over $30,000,000 are installed in a special building; over 30 of these systems have four or five axes of motion. It is the most impressive single N/C facility we have ever seen.

Resources controlled directly by the manager are about 300 personnel (machine operators and their chain of supervision), 80 N/C machines, and a smaller number of manually-operated machines. These resources cost Douglas $4,000 per hour of operation. There are many service groups

whose function is, in part, supporting the N/C Fabrication Department. Some of these are:

N/C Programming
Tooling
Maintenance
Planning
Production Control
Manufacturing Engineering
Industrial Engineering
Transportation
Purchasing
Quality Control

With a burden of 280%, about 600 people are required in other departments to support the 300 people in N/C Fabrication.

3. How the Manager Controls His Resources.

a. Historical Background. Prior to 1969, this N/C fabrication department had achieved a machine utilization rate of about 25%, a little above the average of the industry. Among the causes for this seemingly low rate were: lack of cutters, fixtures, tapes, materials, operators; machine tool malfunction, lack of maintenance personnel or spare parts; an operator could lack certain instructions, or receive incorrect instructions that produced a rejected part, so that the cycle was delayed until a new forging could be made; transportation could be late delivering support items because of improper priorities; the necessary part or fixture was lost somewhere in the plant and no one could find it.

In 1969 this shop began to manufacture parts for the DC-10 transports, and the Long Beach plant began to assemble them. The product required a very large investment (over $500,000,000) and involved very high risk. To recover its investment, the company would have to sell over 200 units at a price competitive with the products of its two rivals, and have to learn to manufacture them at a cost low enough to obtain the recovery. To assure the on-time flow of inspection-approved, difficult-to-make, vital structural parts to the assembly line, the N/C manager analyzed past problems and decided it was necessary to obtain better control over certain operations and personnel.

Therefore, the manager asked his management for authority to invite computer vendors to submit proposals for a real time data acquisition and display system which would meet his functional specifications; that request was denied. The Douglas Computer Center offered a large estimate (about $1,000,000) but no performance guarantee. The N/C Manager would not fund such an offer.

b. The Existing System. As a result of the factors summarized above, a *totally manual* real time information system was implemented by the manager of the N/C fabrication facility. The goal of the system is to enable the manager to:

1) meet delivery schedules;

2) achieve fairly level machine loading;

3) obtain graphic real time display of work status;

4) perform rescheduling in case of part shortages or machine tool breakdown;

5) facilitate the flow of information from personnel at the shop floor, storage area,

or maintenance to the control room and back;

6) alert personnel to exceptions requiring action.

The system was implemented in 6 months. It employs people as data gatherers, analyzers, and reporters. Using this manual system, the total utilization rate has been raised to 57%, more than double the original figure. The investment in hardware was under $10,000, mostly for telephones.

No facility is built into the system to produce optimal schedules, loading, or lot sizes. Figure 7 contains a diagram of the information flow:

I. Master Schedules detailing aircraft delivery dates are developed in Long Beach.

II. Manufacturing Plans developed by engineers detail the fabrication operations required for each ship set.

III. Schedulers "explode" I and II manually and apply individual operations to machine tools using bar charts.

IV. Schedules for each machine tool are typed. These schedules are split into three categories which are on individual pieces of paper to allow for separate handling. The categories are:

a. past due
b. current
c. future

V. Schedules are posted in the control room on a weekly basis. This is the nerve center of the entire N/C fabrication facility. On the walls of the control center are the following major displays:

1) End-item completion schedule. This shows the due date (from I) of each major item by quantity within week. When a lot is completed that week it is taped over in red. A bar slides over the schedule and is moved each week. Untaped items to the left of the bar are past due, taped items to the right represent future work completed.

2) Schedules for each machine tool (from IV) are posted. Each column represents a machine tool, the three rows: past due, current, future. Past due schedules are printed on colored paper. Summaries (total hours) are written in grease pen under each schedule sheet.

3) Performance history is posted on graphs, e.g., past due hours and scheduled hours per week.

4) Status of constraints, i.e., tool orders, material, N/C tape availability, is maintained in a "visirecord"-type file.

5) Machine tool status displays what work is currently scheduled on the machine, is the machine tool down, and if so, when will it be up, is material available, etc.

VI. Material orders, receipts come into the control room to allow dispatching.

VII. The work is dispatched to the shop floor via telephone and telewriter.

VIII. Machine tool breakdowns, material shortages and job completions come back to the control room by telephone.

IX. Maintenance is called.

X. Maintenance is completed or estimated completion is phoned back.

Figure 8 shows some of the wall displays in the management control center. This system effectively portrays a massive amount of information in summary form. Because the

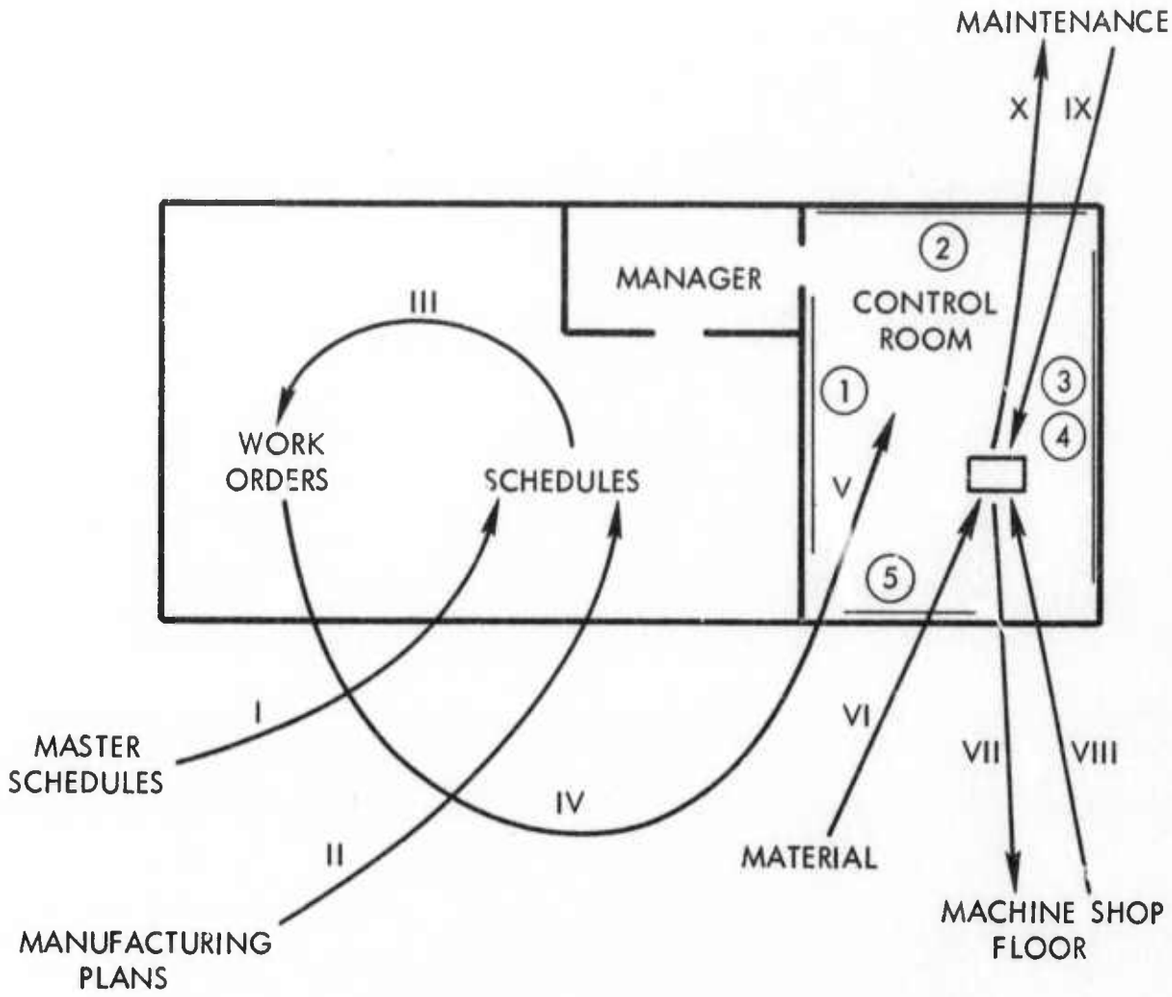

Figure 7. Information flow at Douglas Aircraft Manual N/C Management Control System.

number of relationships between the data is huge, little attempt at dynamic preplanning can occur. As a result, "crises" occur regularly. The occurrence of crises necessitates a daily meeting of the manager with shop personnel during which additional information is interchanged and solution strategies are developed.

In 1972, a series of discussions were held between the N/C Fabrication Manager and representatives of the Computer Center, to consider the computerization of this manual system. At the time of our initial visit in October 1972, the manager had just received an estimate of $500,000 (no performance guaranteed). He decided it would not give him the ability to increase his productivity, and terminated the negotiations. He has made changes in the system since 1969 because his original specifications

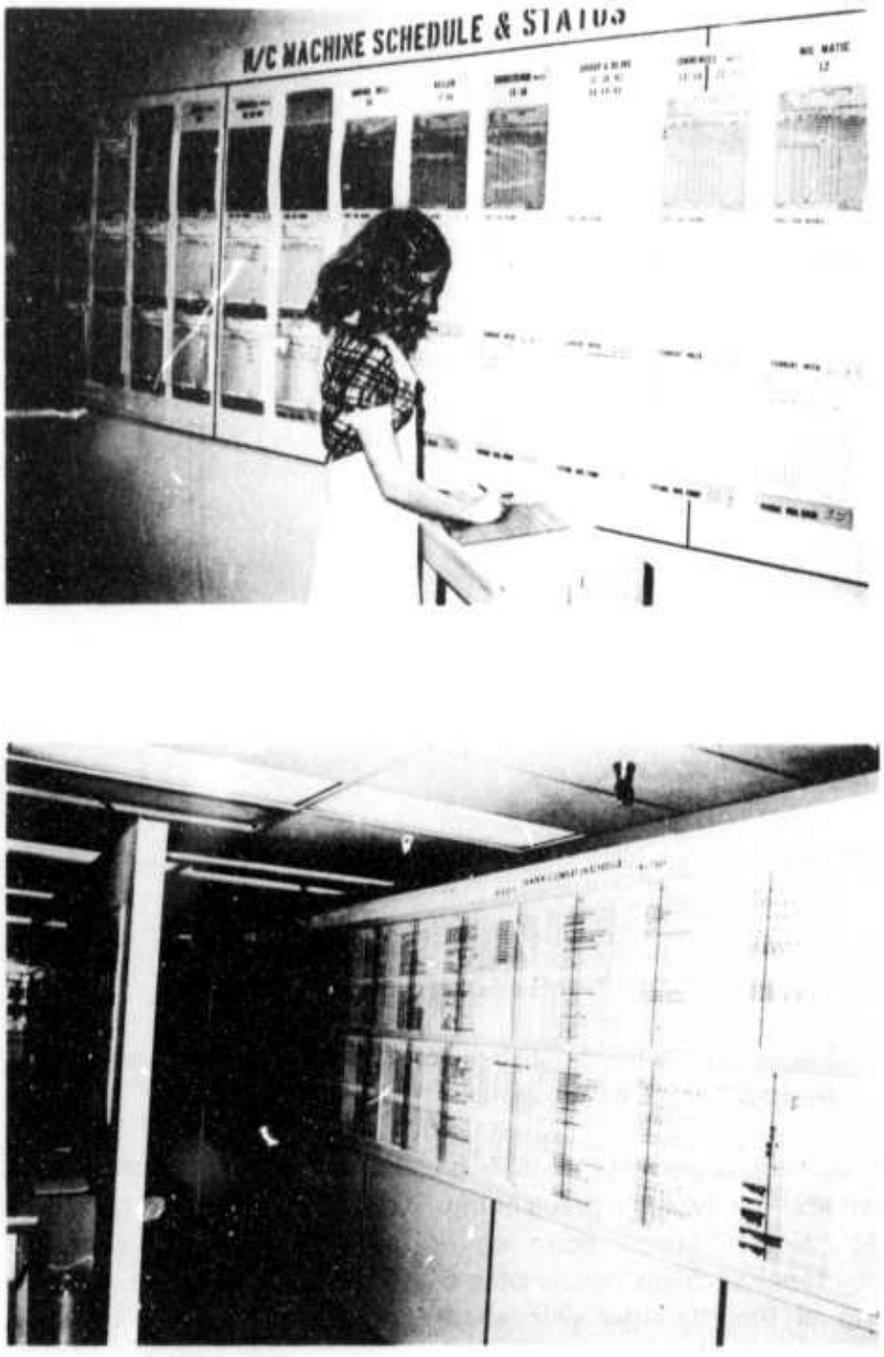

Figure 8. Wall displays at Douglas Aircraft Management Control System.

were not precisely those he found he needed. Recently changes have been infrequent. The latest change took his people 15 minutes to implement.

The manual data center has made it more efficient for the manager to make and implement some decisions, but it supports only a part of his responsibilities. He still spends the first two hours every day meeting with his staff, reviewing the status of critical jobs from a checklist. The rest of the day he and his staff physically track down the location and condition of parts and supplies, give orders to move them, and instruct operators to change the priority of their efforts.

The manager has seen other computer-based production information systems, such as the Rohr N/C Status Display System, and has concluded it is not suitable for him to make real time control decisions. During our visit to Rohr in March 1973, we carefully compared the Rohr system to the Douglas "system" and reached the same conclusion. With the cooperation of the Douglas N/C manager, we prepared a documentary film showing the products and resources of the N/C Fabrication Department, and how he employs the Management Center to control his resources.

Due to the seeming importance of flexible, interactive software systems in this environment, we held a number of discussions with the N/C manager to determine the complexity of the information network that would be required in an effective information system. Appendix G contains a list of 420 vocabulary words which are relevant, culled from several diverse software packages currently existing within Douglas. From these discussions, we estimate that perhaps an additional 500 words would be required in a useful system capable of communicating directly with a manager in a terminology familiar to him.

c. Conclusions - Douglas N/C Fabrication

Our analysis of this facility has supported the conclusions reached in our study of production at Western Gear Corporation: real time software systems currently available as management aids for job shop environments are too costly, too inflexible, and do not support the important managerial function of predicting consequences of incremental changes to existing schedules. An entirely new level of software sophistication, at a reasonable cost, is required. Increased productivity is possible through much more efficient utilization of resources, if truly effective job shop production control systems are developed. Our initial studies show the information environment in job shop manufacturing process control is sufficiently finite to permit development of the needed systems using the latest state of the art software techniques.

D. Conclusions

1. Management of Manufacturing. The major conclusion we reached, as a result of the case studies described above, is that the single development that can have the greatest impact on manufacturing productivity in DOD-related industries is *a system that serves the manufacturing manager* -- that helps him and his subordinates do their job better. This conclusion results from our observation that, in the cases we have studied:

- managers are intelligent, decisive individuals, whose chief responsibility is to

control their resources; their most important resource is the people they control;

- managers are now required to make decisions based on data which is sometimes wrong, too old, too voluminous, yet incomplete, and presented in a form that does not aid the decision-making process; the resulting inefficiencies are the major problem in batch manufacturing.

In short, managers of major manufacturing operations are not obstacles to progress; they are worth supporting with a major system design and implementation effort tailored to increasing their effectiveness in controlling their resources.

There are major consequences resulting from the explicit decision that a system will *serve*[10] a manager:

- the system (and its designers) must accept the manager's assessment of what's important -- his set of priorities;
- it must help the manager gain an accurate, useful conception of the status of his processes and resources;
- the system must provide a useful interface to, and communication among, each of three classes of users:

  i) the manufacturing manager;

  ii) his subordinates (and their subordinates, etc., down to the operators of machines and other persons performing specific manufacturing tasks);

  iii) the manufacturing tools and resources that are under direct process control;

- the system must take into explicit account the *characteristics* of (human) users:

  i) they make occasional errors and need to correct them;

  ii) they need service provided in terms they understand; there is an application-dependent vocabulary that must be understood;

  iii) the user must feel confident he understands the system's behavior and the results it provides; these results must be consonant with his intuitive understanding of the operation of his facility; as a consequence, there must be an evolutionary change from old methods of operation to revised ones. There is therefore a requirement that the user be able to modify and enhance the system to guide this evolution. (Some system enhancements will of course be provided from external sources, e.g., programmers; however, the testing and evaluation of these modules and their eventual integration into the operational system must remain under the user's control.);

  iv) the user will be willing to undergo training in the use of the system if he believes its service to him justifies the training; however, training should neither be excessive, nor assume the "computer programming" paradigm;

- the system must *complement* the user's abilities, i.e., provide capabilities that the user lacks:

  i) storage and analysis of significant amounts of data, and selective retrieval from that collection of data;

[10] We emphasize the distinction between *serving*, which implies a commitment to understand needs and be responsive to them until they are met, and *providing a service*, which has the implication, "there it is -- take it or leave it."

ii) continuous, real time surveillance for exceptional conditions, and alerting of the appropriate parties;

iii) formal decision-making, scheduling, and optimization involving many known or estimated parameters;

iv) modeling of complex systems to derive consequences of potential events and activities;

- the system must be capable of being integrated quickly into an existing facility without major disruption;
- the system must be highly reliable.

The above system characteristics are stated in a very general manner. The following problems are specific examples of the environment in which we find managers currently making decisions and needing assistance:

Problem: A shipment is late or the customer requests early delivery; should he commit to a new date?

Q: What is the current production status of the order?

Q: What is the load in the plant?

Q: What resources and other commitments would rescheduling affect?

Problem: The actual loads on the profile mills are exceeding the forecast by 20%. Why? Will the trend continue? Will it be critical? How can the situation be alleviated?

Q: What parts are on the mill?

Q: Are schedules being met?

Q: Are standard times being exceeded? If so, why?

Q: Was the machine down? Why? Tooling or material not available? Equipment failure?

Problem: The stretch press has required unusually high maintenance lately.

Q: Will this hurt current or future schedule compliance?

Q: Has the equipment been adequately maintained?

Q: Are the parts defective?

Q: Is the work being performed beyond the equipment's capabilities?

Problem: An overload is predicted in heat treatment three months from now.

Q: Will this cause a bottleneck?

Q: Should we reschedule?

Q: Can some parts be jobbed out?

Q: What parts should he schedule overtime?

Q: Should heat treatment be expanded?

Problem: Materials are consistently late to one of the work centers.

Q: What is happening at preceding work centers?

Q: Are move times too short for these items?

Q: Is transportation not doing its job? Why?

Note that we don't expect a system to be capable of interpreting and responding to questions posed exactly as shown above. However, this is the type of question to which answers must be found. The system should be useful to the maximum extent possible in formulating those answers.

Many of the above questions can be answered by rather straightforward querying

of a data base. However, the most persistent type of question which must be answered -- and the type of question which cannot be answered easily by traditional data base retrieval systems -- is "What if...?". What if machine No. 26 is down for maintenance for 4 days? What if supplier B is 2 weeks late in delivery? What is the resultant effect on this job? If some rescheduling is done, what are the effects on other jobs and schedules? What, ultimately, is the effect on profits from monthly billings?

(In formal management sciences, based on mathematical programming, the above type of question is handled by 'sensitivity analysis" -- how sensitive are certain parameters to changes in other ones? A second way of approaching this type of question is modeling and simulation. An important research question is the extent to which each of these techniques can be used, either separately or cooperatively, to provide significant, real time, daily assistance directly to the manufacturing manager of a major batch production facility.)

Section IV of this report contains our recommendations for the development of a Manufacturing Process Control system, including functional specifications and proposed system architecture. This proposed system is a direct result of our conclusion that more effective management and control of batch manufacturing is the greatest potential area of productivity improvement.

2. Automation Technologies. The classical definition of productivity is output per man. The classical means of increasing productivity is automation -- replacing men by machines. During our case studies, we studied the potential benefits to be derived from R & D programs in computer-based automation technologies, ranging from a programmable factory (see Section III.A and Anderson, op. cit.) to incremental enhancements to existing numerically-controlled machine tools.

The potential seems great; as suggested by Section II, manufacturing of DOD-procured items is largely by batch production methods; batch production requires flexibility in the use of resources; computers can bring programmability and flexibility to the control of automated manufacturing resources.

Specifically, in our analyses of TOW, Western Gear, Douglas N/C Fabrication, and other facilities, we considered the current state of the art and the potential for developments in the following areas:

Self-test for machines

Programmable setup for machine tools

Sensory output from machine tools

Adaptive feedback for machine tools

Tool-point sensing for machine tools

Numerically controlling other tools

Programmable assembly machine

Random access conveyor

Automated storage

Programmable testing machine

Programmable pallets

Programmable fixtures

Programmable parts transfer

We evaluated potential developments in each area by two criteria:

a) Individual developments should, if at all possible, be of interest to industry as

stand-alone devices that have the potential of being cost-effective in manufacturing situations as they exist today.

b) Individual developments will, to the extent this is predictable, interface as required with other machines and computers in a nearly completely automated factory of the future.

Our evaluation is that the only potential development areas that meet criterion a) *for a significant number of important DOD suppliers* are:

Self-test for machines

Sensory output from machine tools

Adaptive feedback for machine tools

(We exclude automated storage systems as being commercially available. We do not elaborate further in this report on self-test, sensory output, and adaptive feedback for machine tools, due to their seemingly limited pertinence to the research program of the Information Processing Techniques Directorate of ARPA. It should be noted also that, due to a lack of time and resources we have not considered to any significant depth two important areas of manufacturing: design automation, and visual inspection systems. We especially emphasize the importance of design automation, since the main theme of this report is that better information systems are the key to productivity, and the design process is a vital source of much of the information needed by these systems.)

It should be noted that, on the basis of our observations and discussions with line manufacturing personnel, we concluded that Programmable Assembly Machines that are cost-effective for a significant number of DOD suppliers cannot be developed with currently available technology.[11]

However, the manipulation of objects in a factory, including manipulation for assembly tasks, is *the* labor-intensive operation; essentially all direct labor in manufacturing is involved in manipulative tasks: machine loading and unloading, assembly and fastening operations, material transfer, packaging. There are many reasons why it is important for these operations to become more completely automated:

- to bring them under more direct, effective computer scheduling, monitoring, and control;
- to eliminate hazardous or unhealthy jobs[12];
- to increase uniformity of products, thereby decreasing reject and rework rates and increasing product reliability.

From our analyses of the labor breakdowns in DOD-relevant industries (see Appendix D, Tables D-17 through D-22) and our inspection of the manufacture of many DOD products, we concluded that ARPA should be especially receptive to proposals for research on assembly tasks related to electronic-based units, such as avionic equipment, small radar and communications units, and missile guidance units. Many reasons for this emphasis have been given in earlier sections of this report:

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[11] We stress that all of the conclusions in this report are derived from a study of major DOD suppliers; these conclusions do not necessarily apply to other manufacturing sectors.

[12] The new OSHA (Occupational Safety and Health Administration) regulations will be a major stimulus for increased automation; the working conditions for a significant number of current manufacturing jobs do not meet the OSHA requirements.

• assembly workers constitute 42% of all employees in communications and electronic equipment industries (see Table 4);

• DOD's demand for electronics appears to be constant volume rather than constant function; therefore significant assembly tasks will remain in spite of the continuing revolution in electronic technology;

• the consistently small size and weight of electronic components simplify the mechanical requirements in constructing a prototype assembly machine, and the resulting machine(s) could be broadly applicable to many different electronic-based products;

• a prime requirement in electronic fabrication is the integration of testing procedures; greater mechanization of the fabrication tasks would permit more timely, thorough, computer-controlled testing to be introduced into the fabrication process.

A flexible programmable electronic unit assembly machine would be especially useful in the construction of prototypes; there is often a requirement for 10, or 50, or 100 *identical* units for testing (e.g., destructively, in a missile or "smart bomb"). It is currently very difficult to assure that such prototype units are fabricated identically by hand.

Concerning the assembly of mechanical objects, we became convinced during the course of our investigation that programmable assembly machines will first become cost-effective (and therefore first have a serious impact) in the mass production of commercial products. The *programmability* will be used to allow a family of quite similar products to be handled on one common automated assembly line. Initially, a little flexibility will be used to handle small variations in products. (The use of Unimate industrial robots to handle the welding of various Vega body styles at the General Motors assembly plant at Lordstown, Ohio, is a good example of the use of flexibility to handle a family of products on a common mass production line.) Gradually, as the characteristics of programmable assembly machines are better understood, more flexibility will be introduced to handle more diverse product families. The use of programmable assembly machines in batch production situations with considerable diversity will be a late stage in the evolution of those machines.

Our recommendation for a research program in computer-controlled manipulation of objects is contained in the following section.

IV. RECOMMENDATIONS FOR RESEARCH AND DEVELOPMENT

Previous sections of this report have documented the unique aspects of manufacturing for DOD procurement, the important leverage that DOD has in introducing new manufacturing technologies, and the real need of manufacturers for new technologies shown by our discussions with line management personnel and by our analyses of their operations.

Based on these studies, we concluded that a major ARPA R & D program based on the recommendations in this report can have a vital, important impact on manufacturing productivity. We recommend that an R & D program in manufacturing automation be focused in two areas:

1) *development* of a flexible, manager-oriented Manufacturing Process Control system, and its test and evaluation by in-plant use;

2) continued *research* in the programmable manipulation of objects, with experiments designed to better understand the tradeoffs involved in assembly, material transfer, machine loading, and other tasks involving mechanical dexterity.[13]

[13] We emphasize the distinction between: (i) a development program -- leading to a prototype product capable of being tested and evaluated (within a 3-5 year time period) under actual operating conditions, and having a significant probability of high impact, and (ii) a research program -- performing experiments tailored to gain knowledge, but not having the expectation of producing a product meeting the criteria defined for a development program.

Each recommendation is discussed in detail below.

A. A Manufacturing Process Control System

The term "process control" normally refers to the control of continuous processes, such as oil or steel production. Process control systems must be highly reliable, real time systems capable of performing control functions, as well as monitoring. Our primary recommendation is that a system with these same attributes is vitally needed to assist in the control of the batch production of discrete manufactured products. The difference in the case of discrete manufacture (and the primary reason effective control systems do not currently exist in that environment) is that the complexity and dynamic nature of batch production require continuous, high-level decision-making by a human manager. What he needs to control his resources effectively is a computer-based control system with sufficient flexibility and intelligence to interface both with him and with his resources in that dynamic environment.

1. Functional Requirements. A Manufacturing Process Control (MPC) system is required for use primarily by a manufacturing department manager. It must:

- give him accurate answers to common questions, such as the status of an order, the location of a part, etc.;
- p ovide him or others exception reports when specified limit conditions have been reached, and enforce a user response;
- provide status displays for critical operations, and enforce user response to certain conditions;
- enable the manager to communicate with and control certain personnel, as well as leave a recorded audit trail;
- allow the manager to control the allocation of key items of equipment directly with the computer;
- allow him to explore the consequences of potential decisions;
- be flexible, so that the manager himself can make small changes in its functions as his needs change without system redevelopment;
- be usable directly by the manager, with an interface he finds natural to his task.

2. Other Requirements. For the MPC system to have maximum transferability to a variety of industrial management environments, and to have sufficient reliability to be trusted by a manager as *the* process control system, it must adhere to the highest industrial software engineering standards:

- modular
  - independence of function
  - small blocks of code
- program and data independence
- use standard languages
- independence from operating systems
- minimal use of machine-dependent code
- transaction-based
- interface to batch processing
- interface to other systems
- checkpoint/restart
- fail-soft
- self-monitoring
- completely documented
- thoroughly tested by people independent of the development group

3. Development Plan.

a. System Architecture.

We propose a Manufacturing Process Control system that is highly reliable and yet which incorporates flexibility, user-dependent vocabulary, modeling, and deductive capabilities to the maximum extent possible. We believe the key to such a system is the system architecture in Figure 9.

System A is stand-alone and performs real time data acquisition, monitoring, and resource control functions. It must be highly reliable, fail-soft, and have the other attributes of a process control system. It has a significant data acquisition capability, medium-speed storage and user output capability, but a limited inquiry and command interpretation capability -- most probably with a highly stylized syntax. System A is capable of requesting assistance and receiving commands from System B.

System B is a (potentially shared, potentially remote) "intelligence" resource. It is

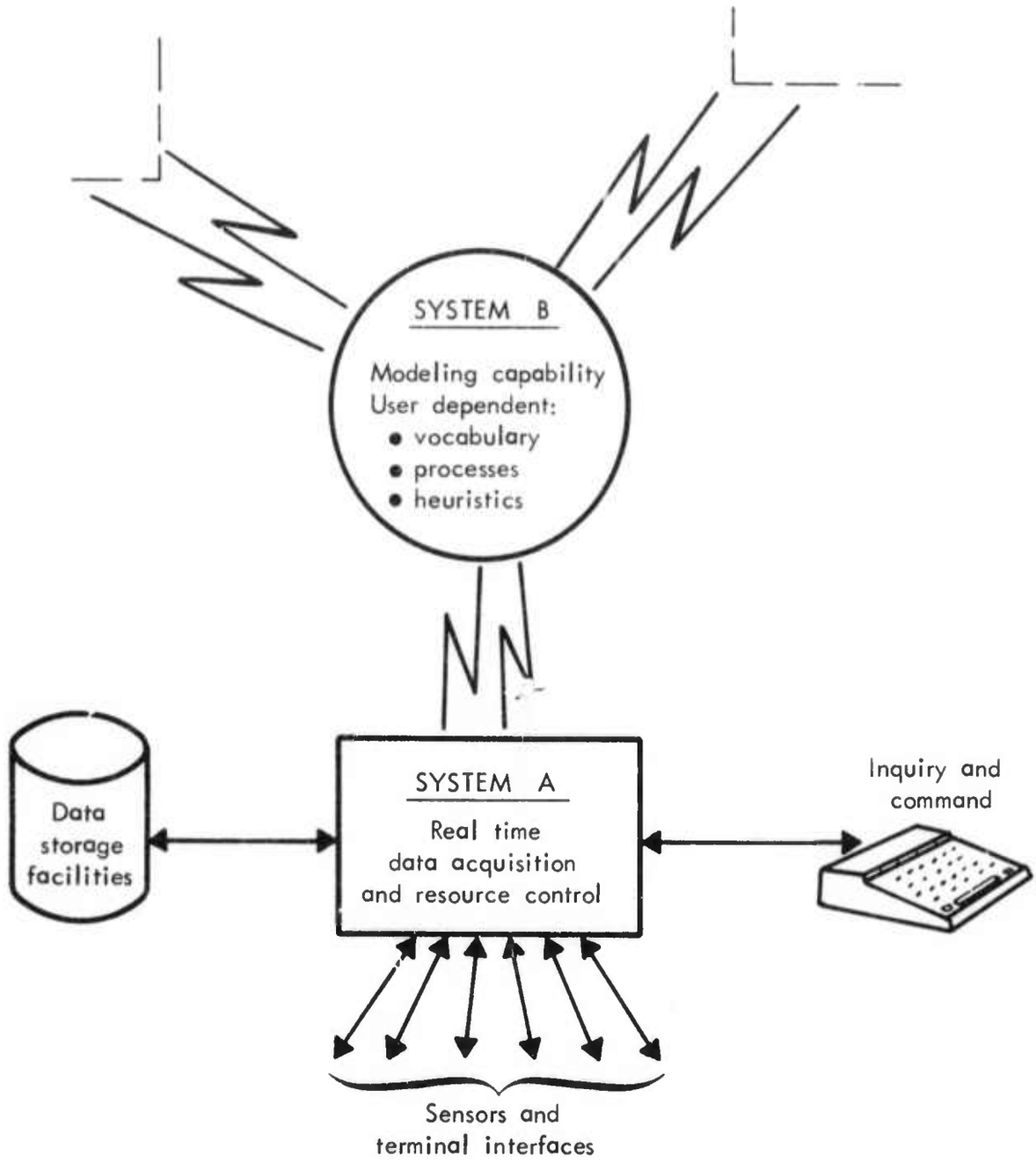

Figure 9. Proposed manufacturing process control system architecture.

capable of performing: (1) a degree of natural language understanding, (2) deduction, (3) modeling, to aid the manager in answering the ubiquitous "What if...?" type of question.

When System A receives a query or command it cannot interpret, that input is passed to System B; B is capable of requesting relevant data from A (possibly using the same limited query format as the terminal interface to A). The resources available in B are used on a demand basis. B's capabilities can be expanded as technology or demand permits, without compromising the integrity of System A. System B should utilize existing system components to the extent possible.

This framework permits the gradual introduction of "intelligent system" technology into that manufacturing environment having the greatest potential payoff: control of resources in a complex, batch production manufacturing operation.

b. Implementation Plan

We feel the Manufacturing Process Control system described above must be implemented according to the carefully graduated program shown in Table 9.

In summary, we propose an initial engineering state of the art system be used as a means for gaining a thorough understanding of the environment; this understanding will then be used to develop a system whose capabilities and costs are known to be highly relevant and highly useful. *A thorough understanding of the interactions within a complex community of system users must precede the development of a system serving (and, potentially, partially supplanting) that community.* The manufacturing production management environment is, in our judgment, the most productive one in which this analysis and resultant system development program can be performed.

c. Estimated Benefits and Payoff

It is, of course, difficult to predict very accurately the benefits to be derived from the installation of the MPC system described above. However, the following data are relevant in making such an estimate:

1) the manufacturing managers we consulted believe such a system is the single most important development program that is required for increasing their facilities' productivity;

2) such an MPC system is directly relevant to the vast majority of manufacturing facilities supporting DOD procurement; the effective control of in-process resources is fundamental to all manufacturing operations;

3) an MPC system is the critical component supporting any further advancements in computer-based manufacturing automation. Effective control of resources is required to take advantage of other advanced manufacturing system capabilities.

Taking all of the above into consideration, our best estimate is that an MPC system meeting all of the functional specifications in Section IV.A.1 above, could reduce the cost of complex job shop operations by at least 20% -- in some cases by up to 50%. (Recall from Section II that manufacturing inventories cost DOD over $1 billion/year; a 20% reduction in inventories through improved control by the widespread use of MPC systems could ultimately yield savings

Table 9

MANUFACTURING PROCESS CONTROL SYSTEM IMPLEMENTATION PROGRAM

Month #	
0-3	Create accurate documentation of the information, control, and material flows in one or more existing factory environments. 3-month milestone: written description of existing information, control, and material flows.
3-6	Create specifications for a real-time on-site production control system which encompasses the transactions in the flow analysis; this system (A) must be cost-effective on a stand-alone basis. 6-month milestone: 1) written specifications for System A; 2) agreement by one or more manufacturing managers to install a system meeting these cost and performance specifications.
6-18	Create, debug, test, and install System A in a manufacturing operation. 18-month milestone: installed, operational System A.
18-24	Use System A as a window into the manufacturing system; perform a frequency and cost analysis of the information and control transactions; create an itemized, ordered list of system modifications and enhancements required for major productivity improvement. 24-month milestone: 1) list of System A modifications; 2) System B specifications.
24-36	Develop, install, and evaluate advanced features in Systems A and B. 36-month milestone: an evaluation of what features are, and are not, useful in a real-time, manager-oriented batch production control system, with an evaluation of the extent of their effectiveness in increasing manufacturing productivity.

of $200 million/year.) Most importantly, the development time schedule presented in Section IV.A.3.b allows a test of this prediction in selected manufacturing facilities within 3 to 4 years. Our primary recommendation to ARPA is that such a development and test be made.

B. Research in Automation Technologies

The primary conclusion on automation technologies, presented in Section III.D.2 above, is that ARPA-sponsored research should concentrate on assembly and testing tasks related to electronic-based units.

We feel that a research program in this area should be based on the validation procedures that we used in the present study:

- perform case analyses of electronic fabrication operations currently being used, and obtain estimates, from manufacturing representatives with line responsibility, of the expected changes in fabrication technology to be utilized by their facility during the next decade;
- form an Advisory Council of line manufacturing representatives to validate the conclusions of that study and the functional specifications derived from it for a prototype machine;
- perform an R&D program in cooperation with representatives of relevant industry groups to develop prototype systems;
- arrange for on-site test and evaluation of prototype systems in actual production environments.

Our preliminary examination of electronic assembly operations indicates this is an area in which considerable computer-based machine flexibility is required. The nature of the physical processes involved leads to such conditions as accidental drops of solder causing unexpected circuit errors, and "jiggling" heuristics needed for proper plug and board insertions. (There is also an important need to explore redesign possibilities for plugs, sockets, and components to make them more amenable to manipulation by machine.) Much of the research on manipulation and machine dexterity performed in the area of electronic unit fabrication will be relevant to the more difficult and more varied task of mechanical assembly of discrete objects.

C. Concluding Remarks

The Advanced Research Projects Agency has played an important role in sponsoring high-impact research and development in the United States. This report has shown the research and development program in computer-based manufacturing systems outlined above has:

- potentially great impact on increasing the productivity of DOD suppliers;
- even greater importance to the U.S. economy and to improving the U.S. balance of trade;
- a requirement for advanced computer technologies in which the ARPA contractor community has a demonstrated interest.

We sincerely hope this report will form the foundation of an ARPA-sponsored R & D program in advanced, computer-based manufacturing systems. The potential benefits are enormous and are vitally needed now.

APPENDIX A:

DESCRIPTIONS OF STANDARD INDUSTRIAL CLASSIFICATION CATEGORIES

Source: United States Department of Commerce
Bureau of Domestic Commerce
Industry Profiles (1958-1969)
pp. 274-297

legend:
(i)=intermittent contact
(r)=regular contact

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J. Massara IBM Corporation Federal Systems Division Owego, N.Y.	7 Oct 71	Anderson
William Winters G.M. Technical Center Warren, Michigan	11 Oct 71	Brewer, Groner, Sibley
R. Glorio A.M.F. Versatran Detroit, Michigan	12 Oct 71	Brewer, Groner, Sibley
J. O'Reilly Ford Motor Company World Headquarters Detroit, Michigan	12 Oct 71	Brewer, Groner, Sibley
William Spurgeon Bendix Research Labs Southfield, Michigan	13 Oct 71	Brewer, Groner, Sibley

Ken Boyd Kearney-Trecker Milwaukee, Wisconsin	14 Oct 71	Brewer, Groner, Sibley
Frank Long W.F. and John Barnes Co. Babcock and Wilcox Rockford, Illinois	15 Oct 71	Brewer, Groner, Sibley
P. Wood Sundstrand Machine Tool Co. Belvidere, Illinois	16 Oct 71	Brewer, Groner, Sibley
J. Linden Hughes Aircraft Co. El Segundo, California	5 Nov 71	Davis, Groner, Sibley
Howard Laitin Hughes Aircraft Co. Culver City, Calif.	14 Dec 71	Anderson, Brewer, Davis, Ellis, Roseen, Sibley, Uncapher
T. Fischer IBM Corporation San Jose, California	13 Jan 72	Groner, Sibley
R. W. Boesel Lockheed Missile and Space Division Sunnyvale, California	14 Jan 72	Groner, Sibley
R. Nelson Mattel Toy Company Hawthorne, California	25 Feb 72	Sibley
L. W. Salisbury Litton-Melonics Division Canoga Park, Calif.	1 Mar 72	Sibley
Roger Dorf IBM Corporation Rochester, Minn.	2 Aug 72	Anderson

Everett Randlett Cross Fraser, Inc. Detroit, Michigan	22 Aug 72	Reynolds
Michael Mikolay Entrekin Computers Flint, Michigan	23 Aug 72	Reynolds
James Barth Swanson-Erie Corp. Erie, Penna.	24 Aug 72	Reynolds
Richard Bodine Bodine Corporation Bridgeport, Conn.	25 Aug 72	Reynolds
Lyell Tullis Gilman Engineering & Mfg. Co. Janesville, Wisconsin	28 Aug 72	Reynolds
Mr. William Beeby Manager, Process Assembly The Boeing Company Auburn, Washington	(i)	Anderson, Rosenberg
Mr. Clint T. Hays Manager, N/C Fabrication Douglas Aircraft Company Torrance, Calif.	(r)	Anderson, Rosenberg Hinds
Mr. Maury Kalnitz IBM Corporation Mohansic, New York	(i)	Anderson
Mr. Harvey Buffum Director, Operations Technology The Boeing Company Renton, Washington	13 Dec 72	Anderson, Rosenberg
Mr. Ronald Patitz Manufacturing Manager Precision Products Division Western Gear Corporation Lynwood, Calif.	(r)	Anderson, Rosenberg Hinds

Mr. Harry Davis Hughes Aircraft Company Tuscon, Arizona	(1)	Anderson, Rosenberg, Brewer
Donald J. Reifer Hughes Aircraft Company Culver City, Calif.	(1)	Anderson, Rosenberg
A. Stone, D. Gustason, X. Kohan Hughes Aircraft Company El Segundo, Calif.	(1)	Anderson, Rosenberg
Tom Bernard Director, Computer Systems and Services Rohr Corporation Chula Vista, Calif.	6 Mar 73	Anderson, Kamrany Rosenberg, Lientz Brewer
Richard E. Pugliese, Walter Claus Large Systems Plant Burroughs Corporation City of Industry, Calif.	21 May 73	Anderson, Balke, Rosenberg

CONFERENCES

Description	Dates	Participating Project Members
Society of Manufacturing Engineers CAD/CAM Conference Atlanta, Georgia	1-3 Feb 72	Sibley
Engineering Foundation Conference on Pattern Information Processing Airlie House, Virginia	23-27 Feb 72	Anderson

Second International Symposium on Industrial Robots Chicago, Illinois	16-18 May 72	Brewer
1972 International Machine Tool Show Chicago, Illinois	12-13 Sept 72	Brewer
First National Conference on Remotely Manned Systems California Institute of Technology Pasadena, Calif.	13-15 Sept 72	Anderson
NSF Conference on Productivity in the Durable Goods Industry University of Massachusetts Amherst, Mass.	4-6 Oct 72	Kamrany
NSF Workshop on Sensors for Automation Cambridge, Mass.	10-12 Apr 73	Anderson
Engineering Foundation Conference on Making Service Industries More Productive Through Computers and Automation Henniker, New Hampshire	13-17 Aug 73	Anderson
Third International Joint Conference on Artifical Intelligence Stanford University Stanford, California	20-23 Aug 73	Anderson

APPENDIX B:

DEFINITIONS OF ECONOMIC TERMS

Source: United States Department of Commerce
Bureau of Domestic Commerce
Industry Profiles (1958-1969)
pp. vii-x

Introduction

For each of the 527 manufacturing industries covered, *Industry Profiles* presents 20 basic data series relating to employment, payrolls, manhours, value of shipments, value added by manufacture, capital expenditures, inventories, and selected averages. These series were obtained from the 1963 and 1967 Censuses of Manufacturers and the 1968 Annual Survey of Manufacturers, published by the Bureau of the Census. Data are shown for the years 1958 through 1969.

Industry data shown refer to the two-, three-, and four-digit industries as defined in the Office of Management and Budget's Standard Industrial Classification (SIC) of 1967. For the years 1958, 1963, and 1967, industry statistics were developed from a complete census of all manufacturing establishments. Data for all other years are based on reports from a sample consisting of approximately 65,000 establishments. Each reporting establishment was assigned an industry code on the basis of its major product or group of products.

In this publication in some instances it was necessary to combine industries in order to present comparable data for the entire period shown. Combined industries are identified in this volume by an "x" as the last digit of the industry code. The industries included are shown with the title for each such profile.

Though each reporting establishment is classified in an industry on the basis of its major product or activity, the industry aggregates shown reflect the total activity of the establishments so classified. The value of shipments data in this publication represent all of the shipments and receipts of the establishment classified in the specific industries, including the shipments of primary products, secondary products and miscellaneous receipts. They differ from the value of shipments on a product basis. The latter, for which data are not shown in this release, represents the total value of shipments of the specific groups of products regardless of the classification of the establishment from which they were shipped.

1969 Data

Data for 1969 are from the preliminary Annual Survey of Manufactures release of June, 1971. These preliminary data are developed from a sample used in the preliminary 1967 census reports and in preceding annual survey years.

All of the 1969 estimates shown, except capital expenditures, are computed by adding the net change between 1968 and 1969, as estimated from the sample, to the 1967 Census of Manufactures totals. Prior to the issuance of the final 1969 Annual Survey of Manufactures Volume, the user may revise these preliminary estimates by means of the final 1967 Census reports. Revised estimates can be derived as follows:

1969 (Revised) = 1969 (Preliminary) + 1968 (Final) − 1967 (Final)

Data for all years except the complete census years of 1958, 1963 and 1967 are based on sample surveys and are therefore subject to sampling errors. Data and computations for which the sampling error exceeds 15 percent are marked with an asterisk (*) in the industry profiles tables.

For most series, the percent change from 1968 to 1969 and the average annual growth rate from 1958 to 1969 have been computed. The average annual growth is computed on the basis of compound interest tables.

Definition of Terms

Table 1 consists primarily of 20 series including ten basic statistical items and ten derived ratios or averages for each industry. In addition, five selected data items, not available on an annual basis, are shown. Each of these is defined below.

Number of Establishments (1967)—Number of plants primarily engaged in producing the products covered in a given industry as defined in the SIC. This information is collected only during the census of manufactures each five years.

Book value of Assets per Employee (1964)—Computed by dividing total employment into book value of fixed assets. This figure is a rough guide to the amount of investment per job required in a given industry and of the capital intensity of individual industries. Data are shown for 1964, the latest data available on book value of fixed assets.

Specialization Ratio (1967)—Derived by dividing the total output (both primary and secondary products) of the industry's plants into their output of products primary to the industry. The resulting percentage measures the extent to which the industry specializes in making its primary products.

Coverage Ratio (1967)—Computed by dividing the total output of products primary to an industry (wherever produced) into the output of primary products produced within the industry. This ratio measures the extent to which the products primary to an industry are shipped by plants classified in that industry.

Concentration Ratio (1967)—The percentage of an industry's value of shipments accounted for by the 4 largest and 8 largest companies.

All Employees—All full-time and part-time employees on the payrolls of operating manufacturing establishments who worked or received pay for any part of the pay period ended nearest the 15th of selected months. Included are all persons on paid sick leave, paid holidays, and paid vacations during these pay periods. Excluded are members of the Armed Forces and pensioners carried on the active rolls but not working during the period. All plant employees including plant officials are included except proprietors and partners of unincorporated firms.

Total employment consists of an average of four monthly figures for "production workers" (March, May, August, and November) plus the March figure for "all other employees."

Payroll—This total represents gross wages and salaries paid in the calendar year to all employees on the payroll of operating manufacturing establishments, following the definition of payrolls used for calculating the Federal withholding tax. Included are all forms of compensation, such as salaries, wages, commissions, dismissal pay, all bonuses, vacation and sick leave pay, and compensation in kind, prior to such deductions as employees' Social Security contributions, withholding taxes, group insurance, union dues, and savings bonds. The total includes salaries of officers of these establishments, if a corporation; it excludes payments to the proprietor or partners, if an unincorporated concern. Also excluded are payments to members of the Armed Forces and pensioners carried on the active payrolls of manufacturing establishments.

Production Workers—All workers (up through the Working foreman level) engaged in fabricating, processing, assembling, inspection, receiving, storage, handling, packing, warehousing, shipping (but not delivering), maintenance, repair, janitorial, watchman services, product development, auxiliary production for plants' own use (e.g., power plant), record-keeping, and other services closely associated with these production operations at the establishment covered by the report. Supervisory employees above the working foreman level are excluded from this category.

Production Worker Man-Hours—All plant man-hours of production workers, as defined above, represents all man-hours worked or paid for at the plant including actual overtime hours (not straight-time equivalent hours). The total excludes hours paid for vacations, holidays, or sick leave, when the employee was not at the plant. Where employees elected to work during the vacation period, only actual hours worked by such employees were reported.

Wages—Gross earnings paid in the calendar year to all production workers on the payrolls of operating manufacturing establishments.

Value Added—This measure is derived by adding the values of shipments to the net change, between the beginning and the end of the year, in inventories of finished goods and work in process (may be plus or minus), and subtracting the cost of materials. The value of shipments includes value of product shipments, receipts, for services for others on their materials, miscellaneous receipts (repair work, scrap sales, etc.), and sales of products bought and resold without further manufacture, processing, or assembly. The cost of materials includes the cost of materials, components, parts, containers, fuels, purchased electricity, products bought and resold without processing and the cost of contract work done by others.

"Value added" avoids the duplication in the "value of shipments" figure which results from the use of products of some establishments as materials by others. Consequently, it is useful for comparing the relative economic contributions of the manufacturing process among industries and geographic areas.

Cost of Materials—The term "cost of materials" refers to direct charges actually paid or payable for items consumed or put into production during the year, including freight charges and other direct charges incurred by the establishment in acquiring these materials. Manufacturers included the cost of materials or fuel consumed regardless of whether these items were purchased by the individual establishment from other companies, transferred to it from other establishments of the same com-

pany, or withdrawn from inventory during the year.

To arrive at the industry total cost of materials, separate figures were obtained for: (a) the total delivered cost of all raw materials, semifinished goods, parts, components, containers, scrap, and supplies put into production or used as operating supplies and for repair and maintenance during that year; (b) the amount paid for electric energy purchased; (c) the amount paid for all fuels consumed for heat, power or the generation of electricity; (d) the cost of work done by others on materials or parts furnished by manufacturing establishments (contract work); and, (e) cost of products bought and resold in the same condition. The total excludes the cost of services used, such as advertising, insurance, telephone, etc., and research, developmental, and consulting services of other establishments; it also excludes overhead costs, such as depreciation charges, rent, interest, royalties, etc.; it excludes materials, machinery and equipment used in plant expansion or capitalized repairs which are chargeable to fixed assets accounts.

Value of Shipments—Dollar amounts of the received or receivable net selling values, f.o.b., plant, after discounts and allowances, and excluding freight charges and excise taxes. However, where the products of an industry are customarily delivered by the manufacturing establishment (e.g., bakery products, fluid milk, and soft drinks), the value of shipments is based on the delivered price of the goods.

Included in value of shipments are: all items made by or for each establishment from materials owned by it, whether sold, transferred to other plants of the same company, or shipped on consignment; receipts for contract work, and receipts for such miscellaneous activities as sale of scrap and refuse, installation work by plant employees, research and development, and repair work. The net selling value of products made in one plant on a contract basis from materials owned by others was reported by the plant providing the materials. The value of products bought and resold without further processing (merchandising) was reported separately and is included in the value of shipments totals for each industry.

For multi-unit companies, the value of products transferred to other establishments of the same company (i.e., other manufacturing plants, separate sales branches, or retail stores) was tabulated as though each establishment were a separate economic unit. Included in "value of interplant transfers within the company" are not only the direct costs of production but also a reasonable proportion of "all other costs" (including company overhead) and profit.

Capital Expenditures—For establishments in operation and establishments under construction but not yet in operation, these data include expenditures for (a) permanent additions and major alterations to manufacturing establishments and (b) new machinery and equipment used for replacement purposes and additions to plant capacity, if these are of the type for which depreciation accounts are ordinarily maintained.

These totals exclude that portion of expenditures for new facilities and equipment leased from nonmanufacturing concerns, new facilities owned by the Federal Government but operated under contract by private companies, and plant and equipment furnished to the manufacturer by communities and organizations. Expenditures for used plant and equipment, expenditures for land, and cost of maintenance and repairs charged as current operating expense are also omitted.

End-of-Year Inventories—Respondents were asked to report their inventories at approximate current costs if feasible; otherwise "at book values." Since different methods of inventory valuation are used (LIFO, FIFO, etc.) the definition of the value of inventories aggregate for all establishments in an industry is not precise. The figures on change in inventory between years are of considerably greater significance.

Value Added as Percent of Shipments—Computed by dividing "value of shipments" into "value added." The resulting percentage shows the contribution of an industry to its value of shipments. The complement of that percentage (100.0 minus the percentage), which is not shown, would be an approximation of the importance of the cost of materials of the industry.

Inventories as Percent of Shipments—Computed by dividing the value of shipments into end-of-year inventories. This is an indicator of turnover rates and levels of sales activity among industries.

Payroll as Percent of Value Added—Computed by dividing value added into payroll to obtain this measure of labor intensity.

Value of Shipments per Production Worker—Computed by dividing "production workers" into "value of shipments." It is important to note that the "value of shipments" may be affected by several

factors, such as cost of materials and the importance of receipts and payments for contract work, which have little or no relationship to the number of production workers.

Value Added per Production Worker Man-Hour—Computed by dividing "production workers man-hours" into "value added." Since there are fewer factors in "value added" than in "value of shipments" that are unrelated to the man-hours of production workers, this measure permits comparisons among industries, areas, and establishments.

Wages per Production Worker Man-hour—Computed by dividing "man-hours" into "wages." The resulting dollar figure is a raugh measure of average hourly earnings. It is not a measure of the wage rate since "wages" includes premium payments far overtime as well as vacation and sick leave pay, bonuses, etc.

Annual Man-haurs per Production Workers—Computed by dividing "production workers" into "man-hours."

Indexes af Emplayment, Value Added, and Shipments—Computed on 1967 base to show annual movement of these basic indicators of industry growth.

Tables 2 (page 1) through 5 present rankings of four-digit industries. Tables 2 and 3, respectively, show the 100 largest industries in terms of size of shipments and employment in 1969, and Tables 4 and 5, respectively, show the 100 fastest growth industries in shipments and employment between 1958 and 1969.

The value of shipments used in Table 4 for computing growth ratios between 1958 and 1969 is not adjusted for changes in price or product mix. Industries that have experienced decreases or rapid increases in prices during this period may be substantially under- or over-stated in terms of their growth relative to other industries. Also, data for industries that have undergone substantial changes in praduct mix due to technalagical changes, materials substitution or similar factors, may be somewhat distarted.

Anather factar affecting the growth ratios computed in Tables 4 and 5 arises fram the fact that the 1969 data are estimates based an a sample and, therefore, have standard errars associated with them. Thus, the 1969 data when campared with 1958 will include some changes reflecting the variability due ta sampling.

APPENDIX C:

DESCRIPTIONS OF STANDARD INDUSTRIAL CLASSIFICATION CATEGORIES

Industry Title and Description

SIC code — Industry title and description (S = Specialization ratio -- C = Caverage ratio)—1963

19 See page xxxv.

20 FOOD AND KINDRED PRODUCTS

This major group includes establishments manufacturing foods and beverages for human consumption, and certain related products, such as manufactured ice, chewing gum, vegetable and animal fats and oils, and prepared feeds for animals and fowls.

201 MEAT PRODUCTS:

2011 Meat Packing Plants (S-98; C-86).—Establishments primarily engaged in the slaughtering, for their own account or on a contract basis for the trade, of cattle, hogs, sheep, lambs, calves, horses, and other animals except small game, for meat to be sold or to be used on the same premises in canning and curing, and in making sausage, lard, and other products. Establishments primarily engaged in manufacturing sausages and meat specialties from purchased meats are classified in industry 2013; and establishments primarily engaged in killing, dressing, packing, and canning poultry, rabbits, and other small game are in industry 2015.

Some slaughtering operations are conducted in establishments which are not included in the census of manufactures, such as those chiefly engaged in wholesale or retail trade locker plant services, etc. A check of the 1958 Census of Manufacturers records with those of the U.S. Department of Agriculture indicated that the census of manufacturers included about 90 percent of the volume of commercial livestock slaughter. A similar comparison of the 1963 census slaughter statistics with those of the U.S.D.A. indicates that coverage of commercial slaughter is about at the same level.

2013 Sausages and Other Prepared Meat Products (S-94; C-38).—Establishments primarily engaged in manufacturing sausages, cured meats, smoked meats, canned meats, frozen meats, other prepared meats, and meat specialties from purchased carcasses and other materials. Sausage kitchens and other prepared meat plants operated by packing houses as separate establishments also are included in this industry. Establishments primarily engaged in killing, dressing, and packing poultry, rabbits, and other small game, and those canning poultry are classified in industry 2015. Establishments primarily engaged in the cutting up and resale of purchased fresh carcasses are classified in trade industries.

Prepared meats manufactured in retail and independent wholesale establishments are not included in the census of manufactures.

2015 Poultry and Small Game Dressing and Packing, Wholesale (S-98; C-98).—Establishments primarily engaged in killing, dressing, packing, and canning poultry, rabbits, and other small game for their own account or on a contract basis for the trade. This industry also includes the drying, freezing, and breaking of eggs; but not the cleaning, oil treating, packing and grading of eggs which are classified in wholesale trade.

Poultry and small game killed and dressed at farms, hatcheries, frozen food lockers and wholesale and retail establishments are not included in manufacturing.

202 DAIRY PRODUCTS:

2021 Creamery Butter (S-69; C-77).—Establishments primarily engaged in manufacturing creamery butter.

This industry combined two industries that were separate under the previous classification system: industry 2022, Natural Cheese, and industry 2025, Special Dairy Products.

2022 Cheese, Natural and Processed (S-93; C-96).—Establishments primarily engaged in the manufacture of natural cheese (except cottage cheese), process cheese, cheese foods, and cheese spreads. Establishments primarily engaged in manufacturing cottage cheese are classified in industry 2026.

2023 Condensed and Evaporated Milk (S-80; C-66).—Establishments primarily engaged in manufacturing condensed and evaporated milk, and related products, including ice cream mix and ice milk mix made for sale as such.

2024 Ice Cream and Frozen Deserts (S-93; C-74).—Establishments primarily engaged in manufacturing ice cream and other frozen desserts.

2026 Fluid Milk (S-90; C-95).—Establishments primarily engaged in processing (pasteurizing, homogenizing, vitaminizing, bottling) and distributing fluid milk and cream, and related products.

203 CANNING AND PRESERVING FRUITS, VEGETABLES, AND SEAFOODS:

2031 Canned and Cured Seafoods (S-92; C-95).—Establishments primarily engaged in cooking and canning fish, shrimps, oysters, clams, crabs, and other seafoods; and those engaged in smoking, salting, drying, or otherwise curing fish for the trade. Establishments primarily engaged in shucking and packing fresh oysters in non-sealed containers, or freezing and packaging fresh fish are classified in industry 2036.

2032 Canned Specialties (S-80; C-91).—Establishments primarily engaged in canning specialty products, such as baby foods, "native foods," health foods, and soups, except seafood. Establishments primarily engaged in canning seafood soup are classified in industry 2031, and those primarily engaged in quick freezing canned specialties in industry 2037.

2033 Canned Fruits, Vegetables, Preserves, Jams, and Jellies (S-89; C-91).—Establishments primarily engaged in canning fruits and vegetables, and fruit and vegetable juices; and in manufacturing catsup and similar tomato sauces, preserves, jams, and jellies. Establishments primarily engaged in canning seafood soups are classified in industry 2031; and soups, except seafood, and baby foods in industry 2032.

2034 Dried and Dehydrated Fruits and Vegetables (S-96; C-89).—Establishments primarily engaged in sun drying or artificially dehydrating fruits, vegetables, and nuts, or in manufacturing packaged soup mixes from dehydrated ingredients. Establishments primarily engaged in the grading and marketing of farm dried fruits, such as prunes and raisins, are classified in trade industries.

2035 Pickled Fruits and Vegetables; Vegetable Sauces and Seasonings; Salad Dressings (S-79; C-82).—Establishments primarily engaged in pickling and brining fruits and vegetables and in manufacturing salad dressings, vegetable relishes, sauces, and seasonings. Establishments primarily engaged in manufacturing catsup and similar tomato sauces are classified in industry 2033, and those packing purchased pickles and olives in trade industries.

2036 Fresh or Frozen Packaged Fish (S-95; C-94).—Establishments primarily engaged in preparing fresh, and raw or cooked frozen packaged fish and other seafood. This industry also includes establishments primarily engaged in the shucking and packing of fresh oysters in nonsealed containers.

2037 Frozen Fruits, Fruit Juices, Vegetables and Specialties (S-89; C-89).—Establishments primarily engaged in quick freezing and cold packing (freezing) fruits, fruit juices, vegetables, and specialties. Excluded from this industry are establishments primarily engaged in packing fruits and vegetables for freezing but not freezing the product; cold storage warehouses freezing foods for others, frozen food locker and other establishments freezing for individual consumers or farms and ranches producing frozen fruits and vegetables. Establishments primarily freezing meats and poultry are included in industry Group 201, Meat Products.

204 GRAIN MILL PRODUCTS:—Establishments in this group of industries frequently supplement their manufacturing activities with sales of grain and of commodities produced elsewhere. Such establishments were classified in manufacturing if at least 25 percent of their total receipts were from manufacturing activities, except for industry 2042, Prepared Feeds for Animals and Fowls, where it was required that receipts from manufacturing exceed receipts from merchandising. Most establishments which mixed some feed but did not meet these criteria were included in the 1963 Census of Business, except for some whose principal activity (e.g. custom milling) fell outside the scope of any of the 1963 economic censuses.

2041 Flour and Other Grain Mill Products (S-94; C-78).—This industry comprises establishments primarily engaged in milling flour or meal from grain, except rice (industry 2044). The products of flour mills may be sold plain or in the form of prepared mixes for specific purposes. Establishments primarily engaged in manufacturing prepared flour mixes from purchased ingredients are classified in industry 2045.

2042 Prepared Feeds for Animals and Fowls (S-96; C-93).—This industry comprises establishments primarily engaged in manufacturing prepared feeds for animals and fowls. Prepared feeds include poultry feed, livestock feed, dog food and other pet foods (canned, frozen, and dry). This industry also includes establishments primarily engaged in manufacturing certain feed ingredients and adjuncts, such as alfalfa meal, feed supplements, and feed concentrates. Mills primarily engaged in custom grinding of feeds or other agricultural services are excluded from the census of manufactures.

Substantial quantities of prepared feeds are mixed at locations which are not included in the census of manufactures, such as grain elevators, custom or grist mills, farm supply stores, chick hatcheries, commercial broiler raising establishments, and cattle-feeding operations.

2043 Cereal Preparations (S-80; C-86).—This industry comprises establishments primarily engaged in manufacturing cereal breakfast foods and related preparations. Establishments primarily engaged in manufacturing corn and hominy grits for human consumption are classified in industry 2041.

2044 Rice Milling (S-100; C-100).—This industry comprises establishments primarily engaged in cleaning and polishing rice, and in manufacturing rice flour or meal. Important products of this industry include brown rice, milled rice (including polished rice), rice polish, rice bran, and rice flour.

2045 Blended and Prepared Flour (S-78; C-62).—This industry comprises establishments primarily engaged in the preparation of blended flours and flour mixes from purchased flour (including flour transferred from flour mills owned by the same company). Important products of this industry include phosphated and self-rising flour and prepared flour mixes such as biscuit, cake, doughnut, and pancake mixes. Establishments making the same products from flour milled at the same location are classified in industry 2041. Prior to 1963, refrigerated doughs were not specifically listed on the report forms. The products usually were classified in either industry 2037, or industry 2099, depending upon the description of the refrigerated dough furnished by respondent.

2046 Wet Corn Milling (S-83; C-93).—This industry comprises establishments primarily engaged in milling corn or sorghum grain (milo) by the wet process, and producing starch, syrup, oil, sugar, and byproducts, such as gluten feed and meal. Establishments primarily engaged in manufacturing starch from other vegetable sources (potato, wheat, etc.) are also included. Establishments primarily engaged in manufacturing table syrups from corn syrup and other ingredients, and those manufacturing starch base dessert powders, are classified in industry 2099; those primarily engaged in manufacturing corn meal and grits are classified in industry 2041. Establishments primarily engaged in manufacturing laundry starches are classified in industry 2842.

205 BAKERY PRODUCTS:

2051 Bread and Other Bakery Products, Except Cookies and Crackers (S-98; C-99).—Establishments primarily engaged in manufacturing bread, cakes, and other "perishable" bakery products. Establishments primarily engaged in producing "dry" bakery products, such as biscuit, crackers, and pretzels are classified in industry 2052. Establishments producing bakery products primarily for direct sale on the premises to household consumers are classified in retail trade, industry 5462. Establishments manufacturing bakery products for sale primarily for home service delivery, or through one or more nonbaking retail outlets, are included in industry 2051.

2052 Cookies and Crackers (S-97; C-95).—Establishments primarily engaged in manufacturing biscuit (except raised biscuit), crackers, and similar "dry" bakery products. Establishments primarily engaged in producing "perishable" bakery products are classified in industry 2051.

206 SUGAR:

2061 Cane Sugar, Except Refining Only (S-99; C-100).—Establishments primarily engaged in manufacturing raw sugar, sirup, or finished (granulated or clarified) cane sugar from sugar cane. Establishments primarily engaged in refining sugar from purchased raw cane sirup or sugar sirups are classified in industry 2062.

2062 Cane Sugar Refining (S-100; C-100).—Establishments primarily engaged in refining purchased raw cane sugar and sugar sirup.

2063 Beet Sugar (S-100; C-100).—Establishments primarily engaged in manufacturing sugar from sugar beets.

207 CONFECTIONERY AND RELATED PRODUCTS:

2071 Candy and Other Confectionery Products (S-95; C-95).—Establishments primarily engaged in manufacturing candy, including chocolate candy, salted nuts, other confections and related products. Establishments primarily engaged in manufacturing solid chocolate bars are classified in industry 2072, and chewing gum in industry 2073. Establishments primarily engaged in manufacturing confectionery for direct sale on the premises and those primarily engaged in shelling and roasting nuts are classified in trade industries.

2072 Chocolate and Cocoa Products (S-99; C-82).—Establishments primarily engaged in shelling, roasting, and grinding cocoa beans for the purpose of making chocolate liquor, from which cocoa powder and cocoa butter are derived, and in the further manufacture of solid chocolate bars and chocolate coatings. Establishments primarily engaged in manufacturing products except candy from purchased chocolate and cocoa are classified in industry 2099, and chocolate candies in industry 2071.

2073 Chewing Gum (S-88; C-96).—Establishments primarily engaged in manufacturing chewing gum or chewing gum base.

208 BEVERAGES:

2082 Malt Liquors (S-100; C-100).—Establishments primarily engaged in manufacturing all kinds of malt liquors. Establishments primarily engaged in bottling purchased malt liquors are classified in trade industries.

2083 Malt (S-100; C-95).—Establishments primarily engaged in manufacturing malt or malt byproducts from barley or other grains.

2084 Wines, Brandy, and Brandy Spirits (S-98; C-99)[1].—Establishments primarily engaged in manufacturing wines, brandy, and brandy spirits. This industry also includes bonded storerooms which are engaged in blending wines. Establishments primarily bottling purchased wines, brandy and brandy spirits, but which do not manufacture wines and brandy are classified in trade industries.

2085 Distilled, Rectified, and Blended Liquors (S-98; C-99).—Establishments primarily engaged in manufacturing alcoholic liquors by distillation and rectification, and in manufacturing cordials and alcoholic cocktails by blending processes, or by mixing liquors and other ingredients. Establishments primarily engaged in manufacturing industrial alcohol are classified in industry 2818, and those only bottling purchased liquors in trade industries.

2086 Bottled and Canned Soft Drinks and Carbonated Waters (S-98; C-95).—Establishments primarily engaged in manufacturing soft drinks (nonalcoholic beverages) and carbonated waters. Establishments primarily engaged in manufacturing fruit and vegetable juices are classified in industry 2033, fruit sirups for flavoring in industry 2087, and cider in industry 2099. Establishments primarily engaged in bottling natural spring waters are classified in trade industries.

2087 Flavoring Extracts and Flavoring Sirups, N.E.C. (S-90; C-79).—Establishments primarily engaged in manufacturing flavoring extracts, sirups, and fruit juices, n.e.c., for soda fountain use or for the manufacture of soft drinks, and colors for bakers' and confectioners' use. Establishments primarily engaged in manufacturing chocolate sirup are classified in industry 2072, and mixed or blended sweetening sirup and molasses in industry 2099.

209 MISCELLANEOUS FOOD PREPARATIONS AND KINDRED PRODUCTS:

2091 Cottonseed Oil Mills (S-89; C-91).—Establishments primarily engaged in manufacturing cottonseed oil, and byproduct cake, meal, and linters. Establishments primarily engaged in refining cottonseed oil into edible cooking oils are classified in industry 2096.

2092 Soybean Oil Mills (S-89; C-95).—Establishments primarily engaged in manufacturing soybean oil, and byproduct cake and meal. Establishments primarily engaged in refining soybean oil into edible cooking oils are classified in industry 2096.

2093 Vegetable Oil Mills, Except Corn, Cottonseed, and Soybean (S-84; C-83).—Establishments primarily engaged in manufacturing vegetable oils and byproduct cake and meal, except corn, cottonseed, and soybean. Establishments primarily engaged in refining vegetable oils into edible cooking oils are classified in industry 2096, and those refining these oils for medical purposes in industry 2833.

2094 Animal and Marine Fats and Oils, Including Grease and Tallow (S-94; C-66).—Establishments primarily engaged in rendering inedible grease and tallow from animal fat, bone, and meat scraps, or in manufacturing animal oil, n.e.c., including fish oil and other marine animal oils, and byproduct meal. Establishments primarily engaged in refining marine animal oils for

medicinal purposes are classified in industry 2833. Establishments primarily engaged in manufacturing fatty acids are classified in industry 2899. Establishments primarily engaged in manufacturing lard are classified in industry Group 201.

This industry combined two industries that were separate under the previous classification system: industry 2094 and industry 2095.

2095 Roasted Coffee (S-90; C-99).—Establishments primarily engaged in the manufacture of roasted and concentrated coffee. Roasted coffee may be whole bean or ground. Concentrated coffee produced may be in either liquid or powdered form.

This is a new industry classification. Previously, roasted coffee was classified in industry 2099.

2096 Shortening, Table Oils, Margarine and Other Edible Fats and Oils, N.E.C. (S-88; C-89).—Establishments primarily engaged in manufacturing shortening, table oils, margarine, and other edible fats and oils, n.e.c., by further processing of animal and vegetable oils. Establishments primarily engaged in producing corn oil are classified in industry 2046.

2097 Manufactured Ice (S-99; C-100).—Establishments primarily engaged in manufacturing ice for sale. Ice plants operated by public utility companies are included in this industry. Establishments primarily engaged in manufacturing dry ice are classified in industry 2813, and the harvesting and storage of natural ice for sale in trade industries.

2098 Macaroni, Spaghetti, Vermicelli, and Noodles (S-96; C-94).—Establishments primarily engaged in manufacturing dry macaroni, spaghetti, vermicelli, and noodles. Establishments primarily engaged in manufacturing canned macaroni, spaghetti, etc., are classified in industry 2032.

2099 Food Preparations, N.E.C. (S-91; C-78).—Establishments primarily engaged in manufacturing prepared foods and miscellaneous specialties, n.e.c., such as baking powder, yeast, and other leavening compounds; desserts (ready-to-mix); sweetening sirups and molasses; vinegar and cider; chocolate and cocoa products, except confectionary, made from purchased chocolate; potato and corn chips, sticks, etc. (bagged or canned); and other food preparations not elsewhere classified.

The definition of this industry was changed from the previous definition. Roasted coffee was removed from this industry and is now separately defined as industry 2095.

21 TOBACCO MANUFACTURES

This major group includes establishments engaged in manufacturing cigarettes, cigars, smoking and chewing tobacco, and snuff, and in stemming and redrying tobacco. The manufacture of insecticides from tobacco byproducts is included in Major Group 28.

211 CIGARETTES:

2111 Cigarettes (S-97; C-100).—Establishments primarily engaged in the manufacture of cigarettes.

212 CIGARS:

2121 Cigars (S-100; C-100).—Establishments primarily engaged in the manufacture of cigars.

213 TOBACCO (CHEWING AND SMOKING) AND SNUFF:

2131 Tobacco (Chewing and Smoking) and Snuff (S-97; C-67).—Establishments primarily engaged in the manufacture of chewing and smoking tobacco and snuff.

214 TOBACCO STEMMING AND REDRYING:

2141 Tobacco Stemming and Redrying (S-100; C-100).—Establishments primarily engaged in the stemming and redrying of tobacco. Establishments which sell leaf tobacco as merchant wholesalers, agents, or brokers, and which also may be engaged in stemming tobacco are not included in this industry. Leaf tobacco warehouses which may be engaged in stemming tobacco are not included in this industry.

22 TEXTILE MILL PRODUCTS

This major group includes establishments engaged in performing any of the following operations: (1) preparation of fiber and subsequent manufacturing of yarn, thread, braids, twine, and cordage; (2) manufacturing broad woven fabric, narrow woven fabric, knit fabric, and carpets and rugs from yarn; (3) dyeing and finishing fiber, yarn, fabric, and knit apparel; (4) coating, waterproofing, or otherwise treating fabric; (5) the integrated manufacture of knit apparel and other finished articles from yarn; and (6) the manufacture of felt goods, lace goods, banded-fiber fabrics, and miscellaneous textiles.

This classification makes no distinction between the two types of organizations which operate in the textile industry: (1) the "integrated" mill which purchases materials, produces textiles and related articles within the establishment, and sells the finished products; and (2) the "contract" or "commission" mill which processes materials owned by others. Converters or other non-manufacturing establishments which assign materials to contract mills for processing (other than knitting) are classified in non-manufacturing industries; establishments which assign yarns to outside contractors or commission knitters for the production of knit products are classified in industry Group 225.

221 BROAD WOVEN FABRIC MILLS, COTTON:

2211 Broad Woven Fabric Mills, Cotton (S-92; C-80).—Establishments primarily engaged in weaving fabrics over 12 inches in width, wholly or chiefly of cotton. Establishments primarily engaged in weaving cotton carpets and rugs are classified in industry 2271; those tufting carpets and rugs in industry 2272; and those making tire and cord fabric in industry 2296.

In the product coding system for the 1963 Census of Manufactures, finished cotton fabrics and certain cotton fabricated products were classified as primary to industry 2211 when made in weaving mills. Similar products made in non-weaving establishments were classified as primary to the appropriate industry; for example, sheets made in strictly cut-and-sew plants were classified as primary to industry 2392.

222 BROAD WOVEN FABRIC MILLS, MAN-MADE FIBER AND SILK:

2221 Broad Woven Fabric Mills, Man-Made Fiber and Silk (S-86; C-82).—Establishments primarily engaged in weaving fabrics over 12 inches in width, wholly or chiefly of silk and man-made fibers including gloss. Establishments primarily engaged in weaving carpets and rugs from these fibers are classified in industry 2271; those tufting carpets and rugs from these fibers in industry 2272; and those making tire cord and fabric in industry 2296.

In the product coding system for the 1963 Census of Manufactures, finished synthetic and silk fabrics and blankets were classified as primary to industry 2221 when made in weaving mills. Similar products made in non-weaving establishments were classified as primary to the appropriate industry; for example, synthetic fabrics finished in establishments engaged only in dyeing or printing were classified as primary to industry 2262.

223 BROAD WOVEN FABRIC MILLS, WOOL: INCLUDING DYEING AND FINISHING:

2231 Broad Woven Fabric Mills, Wool: Including Dyeing and Finishing (S-86; C-96).—Establishments primarily engaged in weaving fabrics over 12 inches in width, wholly or chiefly by weight of wool, mohair, or similar animal fibers; those dyeing and finishing woven wool fabrics or dyeing wool, tops, or yarn; and those shrinking and sponging wool goods for the trade. Establishments primarily engaged in weaving wool carpets and rugs are classified in industry 2271, and those tufting wool carpets and rugs in industry 2272.

224 NARROW FABRICS AND OTHER SMALLWARES MILLS: COTTON, WOOL, SILK, AND MAN-MADE FIBER:

2241 Narrow Fabrics and Other Smallwares Mills: Cotton, Wool, Silk, and Man-Made Fiber (S-91; C-97).—Establishments primarily engaged in weaving or braiding fabrics 12 inches or narrower in width of cotton, wool, silk, and man-made fibers, including glass fibers. Establishments primarily engaged in weaving or braiding fabrics 12 inches or narrower in width of fabric-covered elastic yarn are also included in this industry.

225 KNITTING MILLS:

2251 Women's Full-Length and Knee-Length Hosiery, Seamless and Full-Fashioned (S-96; C-94).—Establishments primarily engaged in knitting, dyeing, or finishing women's and misses' full-length and knee-length hosiery, both seamless and full-fashioned.

This new industry definition represents a substantial revision from the classification system used in 1958. Prior to 1963, industry 2251 included establishments primarily engaged in production of full-fashioned hosiery, while industry 2252 consisted of establishments engaged primarily in the production of seamless (circular knit) hosiery. For 1963, the classifications for hosiery mills were revised to include in 2251 those mills primarily engaged in producing women's and misses' hosiery, except socks, and in 2252 mills engaged in producing all other hosiery.

2252 Hosiery, Except Women's Full-Length and Knee-Length Hosiery (S-91; C-96).—Establishments primarily engaged in knitting, dyeing, or finishing hosiery, except women's and misses' full-length and knee-length seamless and full-fashioned hosiery. See definition of industry 2251, above, for revision of the SIC for this industry as of 1963.

2253 Knit Outerwear Mills (S·92; C·97).—Establishments primarily engaged in knitting outerwear from yarn, or in manufacturing outerwear from knit fabric produced in the same establishment. Establishments primarily engaged in hand knitting outerwear for the trade are included in this industry. Establishments primarily engaged in manufacturing woven or purchased knit fabric gloves and mittens are classified in industry 2381, and those manufacturing outerwear from purchased knit fabric in Major Group 23.

2254 Knit Underwear Mills (S·89; C·91).—Establishments primarily engaged in knitting underwear and nightwear from yarn, or in manufacturing underwear and nightwear from knit fabric produced in the same establishment. Establishments primarily engaged in manufacturing underwear and nightwear from purchased knit fabric are classified in Major Group 23.

2256 Knit Fabric Mills (S·95; C·93).—Establishments primarily engaged in knitting tubular or flat fabric, and in dyeing or finishing knit fabric.

2259 Knitting Mills, N.E.C. (S·93; C·86).—Establishments primarily engaged in knitting gloves and other articles, n.e.c. Establishments primarily engaged in cutting and sewing dress, semidress, and work gloves and mittens from purchased knit fabrics are classified in industry 2381.

226 DYEING AND FINISHING TEXTILES, EXCEPT WOOL FABRICS AND KNIT GOODS:

2261 Finishers of Broad Woven Fabrics of Cotton (S·81; C60[2]).—Establishments primarily engaged in finishing purchased cotton broad woven fabrics, or finishing such fabrics on a commission basis. These finishing operations include bleaching, dyeing, printing (roller, screen, flock, plissé), and other mechanical finishing such as preshrinking, calendering and napping. This industry also includes the shrinking and spanging of cloth for the trade, and the chemical finishing for water-repellency, fire-resistance, and mildew-proofing. Establishments primarily engaged in finishing wool broad woven fabrics are classified in industry 2231; knit goods in Industry Group 225; and those coating or impregnating fabrics in industry 2295.

2262 Finishers of Broad Woven Fabrics of Man-Made Fiber and Silk (S·91; C·46[3]).—Establishments primarily engaged in finishing purchased man-made fiber and silk broad woven fabrics or finishing such fabrics on a commission basis. These finishing operations include bleaching, dyeing printing (roller, screen, flock, plissé); and other mechanical finishing such as preshrinking, calendering, and napping. Establishments primarily engaged in finishing wool broad woven fabrics are classified in industry 2231; knit goods in Industry Group 225; and those coating or impregnating fabrics in industry 2295.

2269 Finishers of Textiles, N.E.C. (S·89; C·64[4]).—Establishments primarily engaged in dyeing and finishing textiles, n.e.c., such as bleaching, dyeing, printing, and finishing of raw stock, yarn, braided goods, and narrow fabrics, except wool. These establishments perform finishing operations on purchased textiles or on a commission basis.

227 FLOOR COVERING MILLS:

2271 Woven Carpets and Rugs (S·77; C·92).—Establishments primarily engaged in weaving carpets and rugs from any textile yarn. Important products of this industry include Axminster, Wilton, velvet, chenille, and similar woven carpets and rugs; and woven automobile and aircraft floor coverings.

2272 Tufted Carpets and Rugs (S·96; C·96).—Establishments primarily engaged in tufting carpets and rugs from any textile fiber. Important products of this industry include tufted carpets, rugs, scatter rugs, and bathmats and bathmat sets except terry woven. Finishers of these products also are included in this industry.

2279 Carpets and Rugs, N.E.C. (S·89; C·46).—Establishments primarily engaged in manufacturing rugs, carpets, art squares, floor mattings, door mats and mattings from twisted paper, grasses, reeds, coir, sisal, jute or rags. Establishments primarily engaged in manufacturing hard-surface floor coverings, except rubber and cork, are classified in industry 3982.

228 YARN AND THREAD MILLS:

2281 Yarn Spinning Mills, Cotton, Man-Made Fibers, and Silk (S·96; C·83).—Establishments primarily engaged in spinning yarn wholly or chiefly by weight of cotton, man-made fiber staple, or silk staple. Establishments primarily engaged in dyeing or finishing purchased yarns or finishing yarns on a commission basis are classified in industry 2269.

2282 Yarn Throwing, Twisting, and Winding Mills, Cotton, Man-Made Fibers and Silk (S·95; C·87).—Establishments primarily engaged in throwing, twisting, winding, or spooling yarn wholly or chiefly by weight of cotton, man-made fibers, or silk. Establishments primarily engaged in dyeing or finishing purchased yarns or finishing yarns on a commission basis are classified in industry 2269.

2283 Yarn Mills, Wool, including Carpet and Rug Yarn (S·85; C·82).—Establishments primarily engaged in spinning, twisting, winding, or spooling yarn (including carpet and rug yarn) wholly or chiefly by weight of wool, mohair, or similar animal fibers. Establishments primarily engaged in dyeing or finishing purchased yarn or finishing yarn on a commission basis are classified in industry 2231.

2284 Thread Mills (S·93; C·90).—Establishments primarily engaged in manufacturing thread from natural or man-made fiber except flax (industry 2299) and wool (industry 2283). Important products of this industry include sewing, crochet, darning, embroidery, tatting, hand knitting, and other handicraft threads.

229 MISCELLANEOUS TEXTILE GOODS:

2291 Felt Goods, Except Woven Felts, and Hats (S·86; C·88).—Establishments primarily engaged in manufacturing pressed felt, regardless of fiber, by means of heat, moisture, and pressure; and those making punched felt for rugs, cushions, and other products from hair, jute, wool, or other fibers by the needle loom process. Establishments primarily engaged in manufacturing woven wool felts and wool haircloth are classified in industry 2231, and those manufacturing felt hats in Industry Group 235.

2292 Lace Goods (S·98; C·91).—Establishments primarily engaged in manufacturing lace machine products, and those primarily engaged in dyeing and finishing lace goods. Establishments primarily engaged in manufacturing Schiffli machine embroideries are classified in industry 2397.

2293 Paddings and Upholstery Filling (S·84; C·81).—Establishments primarily engaged in manufacturing batting, padding, wadding, and filling for upholstery, pillows, quilts, and apparel from curled hair, cotton mill waste, moss, hemp tow, flax tow, kapak, and related materials. Establishments primarily engaged in manufacturing wood excelsior pads and wrappers are classified in industry 2429.

2294 Processed Waste and Recovered Fibers and Flock (S·95; C·86).—Establishments primarily engaged in processing textile mill waste for spinning, padding, batting, or other uses; in recovering textile fibers from clippings and rags; in cutting flock from waste, recovered fibers, or new fiber stock; and in manufacturing oakum and twisted jute packing. Establishments primarily engaged in cleaning and sorting wiping rags or waste are classified in nonmanufacturing industries.

2295 Artificial Leather, Oilcloth, and Other Impregnated and Coated Fabrics, Except Rubberized (S·86; C·83).—Establishments primarily engaged in manufacturing coated and impregnated textiles, and in the special finishing of textiles such as varnishing and waxing. Establishments primarily engaged in rubberizing purchased fabrics are classified in industry 3069, and those primarily engaged in dyeing and finishing textiles in Industry Group 226.

2296 Tire Cord and Fabric (S·87; C·91).—This industry comprises establishments primarily engaged in manufacturing cord and fabric for use in reinforcing rubber tires, industrial belting, fuel cells, and similar uses.

2297 Wool Scouring, Worsted Combing, and Tow to Top Mills (S·94; C·69).—This industry comprises establishments primarily engaged in processing textile fibers to prepare them for spinning. Important processes included in this industry are wool scouring and carbonizing, and combing and converting top.

2298 Cordage and Twine (S·90; C·87).—Establishments primarily engaged in manufacturing rope, cable, cordage, twine, and related products from abaca (Manila), sisal, henequeon, hemp, cotton, paper, jute, flax, man-made fibers including gloss, and other fibers.

2299 Textile Goods, N.E.C. (S·85; C·82).—Establishments primarily engaged in manufacturing linen goods, jute goods except felt, bonded fiber fabrics except felt, and other textile goods, n.e.c. Establishments primarily engaged in manufacturing woven felts are classified in industry 2231, nonwoven felts in industry 2291, and cordage and twine in industry 2298.

23 APPAREL AND OTHER FINISHED PRODUCTS MADE FROM FABRICS AND SIMILAR MATERIALS

This major group, known as the cutting-up or needle trades, includes establishments primarily producing apparel and fabricated products by cutting and sewing purchased woven or knit textile fab-

rics and related materials such as leather, rubberized fabrics, plastics and furs.

Covered in the apparel industries are three types of establishments: (1) the "regular" or inside factories; (2) contract factories; and (3) apparel jobbers. The "regular" factories perform all of the usual manufacturing functions on materials owned by themselves within their own plants; the contract factories manufacture apparel, on a contract or commission basis, on materials supplied to them by others; and apparel jobbers perform only entrepreneurial functions of a manufacturing establishment such as the purchase of raw materials for their own account, the design and preparation of samples, arrangement with outside factories (contractors) for the manufacture of garments from materials supplied by such jobbers, and the sale of finished apparel.

Custom tailors and dressmakers not operating on a factory basis are classified in nonmanufacturing industries. Establishments which primarily purchase and resell finished garments but do not perform the functions of apparel jobbers or manufacturers are classified in the wholesale trades.

The major group also includes manufacturers of fabricated textile products (other than apparel) from purchased fabrics, typically by cutting and sewing or the performance of sewing and related services on textile and similar materials for the trade.

231 MEN'S, YOUTHS', AND BOYS' SUITS, COATS, AND OVERCOATS:

2311 Men's Youths', and Boys' Suits, Coats, and Overcoats (S-92; C-96). —Establishments primarily engaged in manufacturing men's, youths', and boys' suits, coats, and overcoats. Establishments primarily engaged in manufacturing uniforms (military, policemen's, firemen's, etc.) and tailored dress and sport coats, are also included in this industry. Establishments primarily engaged in manufacturing men's work and sport garments (such as lumber-jackets, ski suits, and riding garments) are classified in Industry Group 232, Men's, Youth and Boys' Furnishings, Work Clothing, and Allied Garments.

232 MEN'S, YOUTHS', AND BOYS' FURNISHINGS, WORK CLOTHING AND ALLIED GARMENTS:

2321 Men's, Youths', and Boys' Shirts (Except Work Shirts), Collars, and Nightwear (S-85; C-81[5]).—Establishments primarily engaged in manufacturing men's, youths' and boys' shirts, collars, and nightwear cut and sewed from purchased woven or knit fabric. Establishments primarily engaged in manufacturing knit outerwear sport shirts from purchased knit fabric are also classified in this industry. Establishments primarily engaged in manufacuring work shirts are classified in industry 2328. Knitting mills primarily engaged in manufacturing nightwear are classified in industry 2254, and knit outerwear sport shirts in industry 2253. Men's and boys' knit nightwear made in knitting mills is included in industry 2254.

2322 Men's, Youths', and Boys' Underwear (S-89; C-31[5]).—Establishments primarily engaged in manufacturing men's, youths', and boys' underwear cut and sewed from purchased woven or knit fabric. Knitting mills primarily engaged in manufacturing underwear are classified in industry 2254.

2323 Men's, Youths', and Boys' Neckwear (S-98; C-98).—Establishments primarily engaged in manufacturing men's, youths', and boys' neckties, scarfs, and mufflers cut and sewed from purchased woven or knit fabric. Knitting mills primarily engaged in manufacturing neckties, scarfs, and mufflers are classified in industry 2253.

2327 Men's, Youths', and Boys' Separate Trousers (S-83; C-78).—Establishments primarily engaged in manufacturing men's, youths', and boys' separate trousers and slacks. Establishments primarily engaged in manufacturing complete suits are classified in industry 2311, and work pants in industry 2328.

2328 Work Clothing (S-81; C-90).—Establishments primarily engaged in manufacturing men's and boys' work shirts, pants, and other work clothing and washable service apparel.

2329 Men's, Youths', and Boys' Clothing, N.E.C. (S-83; C-47[5]).—Establishments primarily engaged in manufacturing men's, youths', and boys' clothing, n.e.c. Establishments primarily engaged in manufacturing polo and sport shirts are classified in industry 2331; separate trousers in industry 2327; work clothing in industry 2328; and leather and sheeplined garments in industry 2386. Men's and boys' knit sweaters and other knit outerwear, n.e.c., made in knitting mills are classified as primary products of industry 2253, while men's and boys' knit outerwear, n.e.c., cut and sewed from purchased knit fabric are included in industry 2329.

233 WOMEN'S, MISSES', AND JUNIORS' OUTERWEAR:

2331 Blouses, Waists, and Shirts (S-86; C-69)[4].—Establishments primarily engaged in manufacturing women's, misses', and juniors' blouses, waists, and shirts from purchased woven or knit fabrics. Establishments making knit outerwear shirts from yarns knit in the same establishment are classified in industry 2253.

2335 Dresses (S-96; C-96).—Establishments primarily engaged in manufacturing women's, misses', and juniors' dresses, including ensemble dresses, whether sold by the piece or by the dozen. Knitting mills primarily engaged in manufacturing women's, misses', and juniors' knit dresses and suits are classified in industry 2253.

2337 Suits, Skirts, and Coats (S-88; C-92).—Establishments primarily engaged in manufacturing women's, misses', and juniors' suits, skirts, and coats except fur coats and raincoats. Establishments primarily engaged in manufacturing fur garments are classified in industry 2371, raincoats in industry 2385, and knitting mills primarily engaged in manufacturing knit outerwear in industry 2253.

2339 Women's, Misses', and Juniors' Outerwear, N.E.C. (S-80; C-55)[4]. —Establishments primarily engaged in manufacturing women's, misses', and juniors' outerwear, n.e.c., cut and sewed from purchased woven or knit fabric. Knitting mills primarily engaged in manufacturing outerwear knit sweaters and other knit outerwear, n.e.c., are classified in industry 2253.

234 WOMEN'S, MISSES', CHILDREN'S, AND INFANTS' OUTERGARMENTS, UNDERGARMENTS:

2341 Women's Misses', Children's, and Infants' Underwear and Nightwear (S-93; C-85[5]).—Establishments primarily engaged in manufacturing women's, misses', children's, and infants' underwear and nightwear cut and sewed from purchased woven or knit fabric. Knitting mills primarily engaged in manufacturing underwear and nightwear are classified in industry 2254.

2342 Corsets and Allied Garments (S-95; C-97).—Establishments primarily engaged in manufacturing corsets, corset accessories, and allied garments. Establishments primarily engaged in manufacturing surgical and orthopedic appliances are classified in industry 3842, and in manufacturing garter belts, in industry 2398.

235 HATS, CAPS, AND MILLINERY:

2351 Millinery (S-100; C-100).—Establishments primarily engaged in manufacturing women's, misses', children's, and infants' millinery. Establishments primarily engaged in manufacturing millinery braid and trimmings are classified in industry 2396.

2352 Hats and Caps, Except Millinery (S-98; C-98).—Establishments primarily engaged in manufacturing hats, caps (except millinery) and all hat bodies. Knitting mills primarily engaged in manufacturing caps are classified in industry 2253.

236 GIRLS', CHILDREN'S, AND INFANTS' OUTERWEAR:

2361 Dresses, Blouses, Waists, and Shirts (S-90; C-82[4]).—Establishments primarily engaged in manufacturing girls', children's, and infants' dresses, blouses, waists, and shirts, cut and sewed from purchased woven or knit fabric. Knitting mills primarily engaged in manufacturing outerwear of this type are classified in industry 2253.

2363 Coats and Suits (S-92; C-85).—Establishments primarily engaged in manufacturing girls', children's, and infants' coats and suits, cut and sewed from purchased woven or knit fabric. Knitting mills primarily engaged in manufacturing outerwear of this type are classified in industry 2253.

2369 Girls', Children's and Infants' Outerwear, N.E.C. (S-79; C-67[4]).— Establishments primarily engaged in manufacturing girls', children's, and infants' outerwear, n.e.c., cut and sewed from purchased woven or knit fabric. Knitting mills primarily engaged in manufacturing sweaters and other outerwear, n.e.c., are classified in industry 2253.

237 FUR GOODS:

2371 Fur Goods (S-99; C-100).—Establishments primarily engaged in manufacturing fur coats, and other garments, accessories, and trimmings made of fur. Establishments primarily engaged in manufacturing sheeplined clothing are classified in industry 2386, and those engaged in dyeing and dressing of furs in industry 3992.

238 MISCELLANEOUS APPAREL AND ACCESSORIES:

2381 Dress and Work Gloves, Except Knit and All Leather (S-94; C-82[4]). —Establishments primarily engaged in manufacturing dress, semi-dress, and work gloves and mittens, cut and sewed from purchased woven or knit fabric, or these materials combined with leather. Knitting mills primarily engaged in manufacturing gloves and mittens are classified in industry 2259; establishments pri-

marily engaged in manufacturing leather gloves in Industry 3151; and those manufacturing rubber gloves in Industry 3069.

2384 Robes and Dressing Gowns (S-96; C-94).—Establishments primarily engaged in manufacturing men's and women's robes and dressing gowns.

2385 Raincoats and Other Waterproof Outer Garments (S-92; C-93).—Establishments primarily engaged in manufacturing raincoats from purchased rubberized fabrics and other waterproof outergarments made from such material as pliofilm and cellophane. Establishments primarily engaged in manufacturing oiled fabric work garments are classified in Industry 2328, and those manufacturing vulconized rubber garments and garments made from rubberized fabrics produced in the same establishments are classified in Industry 3069.

2386 Leather and Sheeplined Clothing (S-97; C-83).—Establishments primarily engaged in manufacturing leather and sheeplined garments. Establishments primarily engaged in manufacturing leather gloves and mittens are classified in Industry 3151, and fur garments in industry 2371.

2387 Apparel Belts (S-91; C-94).—Establishments primarily engaged in manufacturing men's and women's apparel belts, regardless of material.

2389 Apparel and Accessories, N.E.C. (S-93; C-82).—Establishments primarily engaged in manufacturing suspenders, garters, handkerchiefs, and other apparel, n.e.c., such as academic caps and gowns, vestments, and theatrical costumes.

239 MISCELLANEOUS FABRICATED TEXTILE PRODUCTS, N.E.C.:—

These establishments are engaged in the manufacture of fabricated textile products (other than apparel) from purchased fabrics. Textile mills producing fabricated textile products from material woven at the same establishment are classified in the appropriate weaving industry (Major Group 22). However, establishments that finish fabrics (bleach, dye, or print) and then further fabricate the fabrics into end products such as sheets are included in the appropriate 239 industry.

2391 Curtains and Draperies (S-96; C-95).—Establishments primarily engaged in manufacturing curtains and draperies from purchased materials.

2392 Housefurnishings, Except Curtains and Draperies (S-88; C-50).—Establishments primarily engaged in manufacturing housefurnishings from purchased materials. Establishments primarily engaged in manufacturing curtains and draperies are classified in industry 2391. Establishments primarily producing housefurnishings from fabrics woven at the same establishment are classified in the appropriate weaving industry, generally industry 2211.

2393 Textile Bags (S-88; C-85).—Establishments primarily engaged in manufacturing cotton, burlap, and other textile bags from purchased fabric. Establishments primarily engged in manufacturing plastic bags are classified in Industry 2643.

2394 Canvas and Related Products (S-92; C-91).—Establishments primarily engaged in manufacturing awnings, tents, and other canvas products from purchased canvas. Establishments primarily engaged in manufacturing canvas bags are classified in industry 2393.

2395 Pleating, Decorative and Novelty Stitching, and Tucking for the Trade (S-97; C-98).—Establishments primarily engaged in pleating, decorative and novelty stitching, and tucking for the trade. Establishments primarily engaged in performing similar services for individuals are classified in service industries. Establishments primarily engaged in manufacturing trimmings are classified in industry 2396.

2396 Automative Trimmings, Apparel Findings, and Related Products (S-98; C-97).—Establishments primarily engaged in manufacturing automobile trimmings, apparel findings, and related products.

2397 Schiffli Machine Embroideries (S-96; C-99).—Establishments primarily engaged in manufacturing Schiffli machine embraideries.

2399 Fabricated Textile Products, N.E.C. (S-86; C-75).—Establishments primarily engaged in manufacturing fabricated textile products, n.e.c.

24 LUMBER AND WOOD PRODUCTS, EXCEPT FURNITURE

This major group includes logging camps engaged in cutting timber and pulpwood; merchant sawmills, lath mills, shingle mills, cooperage stock mills, planing mills, and plywood mills and veneer mills engaged in producing lumber and wood basic materials; and establishments engaged in manufacturing finished articles made entirely or mainly of wood or wood substitutes. Certain types of establishments producing wood products are classified elsewhere. For example, furniture, and office and store fixtures are classified in Major Group 25; pianos, musical instruments, toys and playground equipment, and caskets and coffins in Major Group 39. Woodworking in connection with construction, in the nature of reconditioning and repair, or performed to individual order, is classified in nonmanufacturing industries.

241 LOGGING CAMPS AND LOGGING CONTRACTORS:

2411 Logging Camps and Logging Contractors (S-99; C-90).—Establishments primarily engaged in cutting timber and in producing rough, round, hewn, or riven primary forest or wood raw materials. Independent contractors engaged in estimating or trucking timber but who perform no cutting operations are classified in nonmanufacturing industries. Logging and woods operations conducted in combination with sawmills, pulp mills, or other converting establishments, and not separately reported, are classified in their respective industry groups; namely, with sawmills in Industry Group 242, veneer and plywood mills in Industry Group 243, pulp mills in Major Group 26, and charcoal and wood distillation plants in Industry Group 286. Establishments primarily engaged in the collection of bark, sap, gum, and other forest byproducts are classified in nonmanufacturing industries.

242 SAWMILLS AND PLANING MILLS:

2421 Sawmills and Planing Mills, General (S-89; C-95).—Establishments primarily engaged in sawing rough lumber and timber from logs and bolts, or re-sawing cants and flitches into lumber, including box lumber and softwood cut stock; planing mills combined with sawmills; and separately operated planing mills which are engaged primarily in producing surfaced lumber and standard workings or patterns of lumber. This industry includes establishments primarily engaged in sawing lath and railroad ties, and in producing tobacco hogshead stock and snow fence lath. Establishments primarily engaged in manufacturing box shook or boxes are classified in Industry Group 244; and sash, doors, wood molding, window and door frames, and other fabricated millwork in industry 2431; and hardwood dimension and flooring in industry 2426. Logging camps combined with sawmills, when not separately reported, are included in this industry.

2426 Hardwood Dimension and Flooring Mills (S-86; C-86).—Establishments primarily engaged in manufacturing hardwood dimension lumber and workings therefrom; and other hardwood dimension, semifabricated or ready for assembly; and hardwood flooring. Establishments primarily engaged in manufacturing stairwork, molding, and trim are classified in industry 2431, and those manufacturing textile machinery bobbins, picker sticks, and shuttles in Industry 3552.

2429 Special Product Sawmills, N.E.C. (S-98; C-497).—Establishments primarily engaged in manufacturing wood chips, excelsior, wood shingles, and cooperage stock, and in sawing special products, n.e.c.

243 MILLWORK, VENEER, PLYWOOD AND PREFABRICATED STRUCTURAL WOOD PRODUCTS:

2431 Millwork Plants (S-95; C-93).—Establishments primarily engaged in manufacturing fabricated millwork. Planing mills primarily engaged in producing millwork are included in this industry but planing mills primarily producing standard workings or patterns of lumber are classified in Industry 2421.

2432 Veneer and Plywood Plants (S-92; C-94).—Establishments primarily engaged in producing commercial veneer, either face or technical, and those primarily engaged in manufacturing commercial plywood, including nonwood backed or face veneer and nonwood faced plywood, from veneer produced in the same establishment or from purchased veneer. Establishments primarily engaged in manufacturing prefinished plywood from purchased plywood are also classified in this industry. Establishments primarily engaged in the production of veneer which is used in the same establishment for the manufacture of end products such as fruit and vegetable baskets are classified in Industry 2443, and wood boxes in industries 2441 and 2442.

2433 Prefabricated Wooden Buildings and Structural Members (S-98; C-96).—Establishments primarily engaged in manufacturing prefabricated wooden buildings, sections, and panels; or in producing laminated or fabricated trusses, arches, and other structural members of lumber. Prefabrication on the site of construction is not included in this Industry.

244 WOODEN CONTAINERS:

2441 Nailed and Lock Corner Wooden Boxes and Shook (S-85; C-83).—Establishments primarily engaged in manufacturing nailed and lock corner wooden boxes, and which also may produce shook for nailed and lock corner boxes.

2442 Wirebound Boxes and Crates (S-92; C-93).—Establishments primarily engaged in manufacturing wirebound boxes and crates.

2443 Veneer and Plywood Containers except Boxes and Crates (S-90; C-79).—Establishments primarily engaged in manufacturing veneer and plywood containers, except boxes. This industry includes baskets made primarily of veneer and splint for shipping and marketing fruits and vegetables.

2445 Cooperage (S-97; C-99).—Establishments primarily engaged in manufacturing barrels, tubs, hogsheads, and other containers made of staves, except fruit and vegetable baskets (industry 2443). Establishments primarily engaged in manufacturing tobacco hogshead stock are classified in industry 2421, and those manufacturing cooperage stock in industry 2429.

249 MISCELLANEOUS WOOD PRODUCTS:

2491 Wood Preserving (S-98; C-97).—Establishments primarily engaged in treating wood, sawed or planed in other establishments, with creosote or other preservatives to prevent decay and to protect against fire and insects. This industry also includes the cutting, treating, and selling of poles, posts, and piling, but establishments primarily engaged in manufacturing other wood products, which they may also treat with preservatives, are not included.

2499 Wood Products, N.E.C. (S-92; C-87).—Establishments primarily engaged in turning and shaping wood, and manufacturing miscellaneous wood products, n.e.c., such as lasts and related products, cork products, mirror and picture frames, particle board, hard pressed wood fiberboard and fabricated hardboard products.

The composition of this industry has been slightly changed for 1963, due to the transfer of hard pressed wood fiberboard (hardboard) and fabricated hardboard products to this industry. Prior to 1963, establishments primarily engaged in manufacturing hardboard were classified in industry 2661, and those primarily producing fabricated hardboard products were classified in industry 2649.

25 FURNITURE AND FIXTURES

This major group includes establishments engaged in manufacturing household, office, public building, and restaurant furniture; and office and store fixtures. Establishments primarily engaged in the production of millwork are classified in industry 2431, and wood-working to individual order or in the nature of reconditioning and repair in nonmanufacturing industries.

251 HOUSEHOLD FURNITURE:—

Establishments primarily engaged in making furniture to order of individual household consumers or primarily engaged in renovating furniture or mattresses are classified in nonmanufacturing industries. Establishments primarily engaged in making furniture parts (except wood frames or headboards) are not included in this group of industries but are generally classified in Major Group 24, Lumber and Wood Products or Major Group 34, Fabricated Metal Products. For example, furniture turnings are included in industry 2499, and furniture hardware, including casters are included in industry 3429.

2511 Wood Household Furniture, Except Upholstered (S-94; C-96).—Establishments primarily engaged in manufacturing wood household furniture commonly used in dwellings. This industry also includes the manufacture of wood kitchen cabinets on a factory basis, and camp furniture. Establishments primarily engaged in manufacturing upholstered furniture or wood frames for upholstered furniture are classified in industry 2512, and reed and rattan furniture in industry 2519. Plants primarily engaged in renovating or refinishing furniture are classified in trade industries and plants selling household furniture to household consumers through a retail store on the manufacturing premises are included in retail trade.

2512 Wood Household Furniture, Upholstered (S-92; C-92).—Establishments primarily engaged in manufacturing upholstered furniture on wood frames or wood frames for upholstered furniture. Shops primarily engaged in reupholstering furniture, or upholstering frames to individual order are classified in nonmanufacturing industries. Establishments primarily enaged in manufacturing dual purpose sleep furniture, such as studio couches, convertible sofas, jackknife sofa beds, and chair-beds, are classified in industry 2515 regardless of the materials used in the frame.

2514 Metal Household Furniture (S-88; C-89).—Establishments primarily engaged in manufacturing metal household furniture of a type commonly used in dwellings, whether padded, upholstered, or plain. Establishments primarily engaged in manufacturing dual purpose furniture, such as studio couches, sofa beds, and chair-beds are classified in industry 2515, regardless of the materials used in the frame.

2515 Mattresses and Bedsprings (S-90; C-90).—Establishments primarily engaged in manufacturing innerspring mattresses, boxspring mattresses, and non-innerspring mattresses containing felt, foam rubber, or any other filling material; and assembled wire springs (fabric, cell, or box) for use on beds, couches, and cots. This industry also includes establishments primarily engaged in manufacturing dual purpose sleep furniture, such as studio couches, sofa beds, and chair-beds, regardless of the material used in the frame. Establishments primarily engaged in manufacturing automobile seats and backs are classified in industry 2531; individual wire springs in industry 3481; and paddings and upholstery filling in industry 2293. Establishments primarily engaged in repair, renovating, etc., mattresses and bedsprings are classified in service industries.

2519 Household Furniture, N.E.C. (S-84; C-51).—Establishments primarily engaged in manufacturing reed, rattan, and other wicker furniture, and other household furniture, n.e.c.

252 OFFICE FURNITURE:

2521 Wood Office Furniture (S-90; C-87).—Establishments primarily engaged in manufacturing wood office furniture, whether padded, upholstered or plain.

2522 Metal Office Furniture (S-87; C-89).—Establishments primarily engaged in manufacturing metal office furniture, whether padded or plain. Establishments primarily engaged in manufacturing safes and vaults are classified in industry 3492.

253 PUBLIC BUILDING AND RELATED FURNITURE:

2531 Public Building and Related Furniture (S-85; C-85).—Establishments primarily engaged in manufacturing furniture for schools, theaters, assembly halls, churches, and libraries. Establishments primarily engaged in manufacturing seats for public conveyances, as well as seats for automobiles and aircraft, are included in this industry. Establishments primarily engaged in manufacturing stone furniture are classified in industry 3281, and concrete furniture in industry 3272.

254 PARTITIONS, SHELVING, LOCKERS, AND OFFICE AND STORE FIXTURES:

2541 Wood Partitions, Shelving, Lockers, and Office and Store Fixtures (S-94; C-89).—Establishments primarily engaged in manufacturing wood shelving, lockers, office and store fixtures, and prefabricated partitions, and repated fabricated products.

2542 Metal Partitions, Shelving, Lockers, and Office and Store Fixtures (S-83; C-82).—Establishments primarily engaged in manufacturing metal shelving, lockers, office and store fixtures, prefabricated partitions, and related fabricated products.

259 MISCELLANEOUS FURNITURE AND FIXTURES, N.E.C.:

2591 Venetian Blinds and Shades (S-89; C-90).—Establishments primarily engaged in manufacturing Venetian blinds, regardless of the materials used, and shades except canvas shades and awnings, which are classified in industry 2394.

2599 Furniture and Fixtures, N.E.C. (S-86; C-70).—Establishments primarily engaged in manufacturing furniture and fixtures, n.e.c., including furniture especially designed for use in restaurants.

26 PAPER AND ALLIED PRODUCTS

This major group includes the manufacture of pulps from wood and other cellulose fibers, and rags; the manufacture of paper and paperboard; and the manufacture of paper and paperboard into converted products such as paper coated off the paper machine, paper bags, paper boxes, and envelopes. Certain types of converted paper products are classified elsewhere, such as abrasive paper in industry 3291; carbon paper in industry 3955, and photosensitized and blueprint paper in industry 3861.

261 PULP MILLS:

2611 Pulp Mills (S-88; C-71).—Establishments primarily engaged in manufacturing pulp from wood or from other materials such as rags, linters, wastepaper, and straw. Logging camps operated by pulp mills, and not separately reported, are also included in this industry. Establishments primarily engaged in cutting pulpwood are classified in industry 2411; and pulp mills combined with paper mills or paperboard mills, and not separately reported, are classified with the latter in industries 2621 and 2631, respectively.

In both the 1963 and 1958 Censuses of Manufactures, pulp mills operated in conjunction with a paper and board mill at the same location were permitted to file a combined report for such integrated operations. However, in 1954 all pulp mill activity was separately reported whether or not such pulp mill operations were conducted at the same physical location as an associated

paper or board mill. This change in treatment has the effect of restricting the reporting of a "pulp mill" for classification in industry 2611 in both the 1963 and 1958 censuses to the following situations: (a) those pulp mills which are not affiliated with any paper and board mills and ship all their products to the market; (b) pulp mills affiliated or associated with a primary paper or board mill but which are separately located from the pulp mill; and (c) a few pulp mills affiliated or associated with a primary paper or board mill at the same physical location, where separate departmental records of employment, materials, and fuel costs, shipments, etc., are maintained for the pulp mill from those covering the paper or board mill at that location and the company elected to file such a separate report.

262 PAPER MILLS, EXCEPT BUILDING PAPER MILLS:

2621 Paper Mills, Except Building Paper Mills (S-90; C-92).—Establishments primarily engaged in manufacturing paper (except building paper—industry 2661) from wood pulp and other fibers, and which may also manufacture converted paper products (confined almost exclusively to off-machine paper coating). Pulp mills combined with paper mills, and not separately reported, are also included in this industry; where seperately reported, they are classified in industry 2611. Establishments primarily engaged in manufacturing converted paper products from purchased paper stock are classified in Industry Group 264 or 265.

263 PAPERBOARD MILLS:

2631 Paperboard Mills (S-85; C-90).—Establishments primarily engaged in manufacturing paperboard, including paperboard coated on the paperboard machine, from wood pulp and other fibers; and which may also manufacture converted paperboard products (confined almost exclusively to pasted, lined, laminated or surface-coated paperboard). Pulp mills combined with paperboard mills, and not separately reported, are also included in this industry; where separately reported, they are classified in industry 2611. Establishments primarily engaged in manufacturing converted paperboard products from purchased paperboard are classified in Industry Group 264 or 265.

264 CONVERTED PAPER AND PAPERBOARD PRODUCTS, EXCEPT CONTAINERS AND BOXES:

2641 Paper Coating and Glazing (S-82; C-78).—Establishments primarily engged in manufacturing coated, glazed, or varnished paper from purchased paper. Establishments primarily engaged in coating paper on the paper machine are classified in industry 2621; those manufacturing carbon paper in industry 3955; and photographic and blueprint paper in industry 3861.

Principal products of this industry include: off-machine coated paper; oiled, waxed, and wax-laminated paper and wrappers; pressure sensitive tape; gummed products; and other coated and processed paper.

2642 Envelopes (S-94; C-96).—Establishments primarily engaged in manufacturing envelopes of any description from purchased paper and paperboard. Establishments primarily engaged in manufacturing papeteries (boxed stationery) are classified in in industry 2649.

2643 Bags, Except Textile Bags (S-86; C-88).—Establishments primarily engaged in manufacturing bags from purchased paper, cellophane, acetate, polyethylene, pliofilm, foil, and similar sheet or film materials.

2644 Wallpaper (S-97; C-99).—Establishments primarily engaged in designing, printing, and embossing paper for interior walls, and ceilings. Establishments primarily engaged in manufacturing wall cloth from textile febrics are classified in industry 2295.

2645 Die Cut Paper and Paperboard and Cardboard (S-88; C-82).—Establishments primarily engaged in die cutting purchased paper and paperboard, and in manufacturing cardboard by laminating, lining, or surface coating paperboard.

2646 Pressed and Molded Pulp Goods (S-99; C-96).—Establishments primarily engaged in manufacturing all kinds of pressed and molded pulp goods, including papier-mache articles other than statuary and art goods.

2647 Sanitary Paper Products (S-93; C-97).—Establishments primarily engaged in manufacturing sanitary health products from purchased paper and paperboard. The principal products of this industry are sanitary napkins and tampons; facial tissues; table napkins, toilet paper, towels and wipes. This industry was not separately identified for 1958 in the SIC but was included in industry 2649. Comparable data for 1963 using the previous industry classification for industry 2649 are shown in tables 1 and 2 of the chapter for that industry.

2649 Converted Paper and Paperboard Products, N.E.C. (S-84; C-78).—Establishments primarily engaged in manufacturing from purchased paper or paperboard, miscellaneous converted paper or paperboard products, n.e.c.

The principal products of this industry are: stationery, tablets and related products; wrapping products such as gift wrap and creped wadding; patterns, business machine supplies, tile and laminated wallboard, unprinted tags and other miscellaneous paper and board products.

Sanitary paper products were transferred from this industry and established as a separate industry (2647) for 1963.

265 PAPERBOARD CONTAINERS AND BOXES:—

There is a high degree of integration between industry 2631, and the various board converting industries, except industries 2652 and 2655, which rely principally on market purchases of paperboard. In industries 2651, 2653, and 2654, a substantial part of the converted paperboard is manufactured and converted by the same company, either at the same location or at separate locations.

2651 Folding Paperboard Boxes (S-85; C-88).—Establishments primarily engaged in manufacturing folding paperboard boxes from purchased paperboard.

2652 Set-Up Paperboard Boxes (S-91; C-87).—Establishments primarily engaged in manufacturing set-up paperboard boxes from purchased paperboard.

2653 Corrugated and Solid Fiber Boxes (S-97; C-96).—Establishments primarily engaged in manufacturing corrugated and solid fiber boxes and related products from purchased paperboard of fiber stock. Important products of this industry include corrugated and solid fiberboard boxes, pads, partitions, display items, pallets, single face products, and corrugated sheets.

2654 Sanitary Food Containers (S-92; C-92).—Establishments primarily engaged in manufacturing food containers from special food board. Important products of this industry include fluid milk containers; folding paraffined cartons for butter, margarine, and shortening; ice cream containers; frozen food containers; liquid tight containers; round nested food containers; paper cups for hot or cold drinks; and pails for food and ice cream.

2655 Fiber Cans, Tubes, Drums, and Similar Products (S-95; C-80).—Establishments primarily engaged in manufacturing fiber cans, canes, drums, and similar products with or without metal ends, from purchased materials; and vulcanized fiber boxes.

266 BUILDING PAPER AND BUILDING BOARD MILLS:

2661 Building Paper and Building Board Mills (S-97; C-88).—Establishments primarily engaged in manufacturing building paper and building board, except hard pressed wood fiberboard, from wood pulp and other fibrous materials. Mills producing hard pressed wood fiberboard are classified in industry 2499. In addition, insulation board mills which perform coating operations at their primary mill locations are classified in industry 2952. Pulp mills combined with building paper and building board mills, and not separately reported, are also included in this industry; where separately reported, they are classified in industry 2611. As noted previously in connection with industry 2611, same physical location as paper or board were not required in either the 1963 or the 1958 Census of Manufactures to submit a separate report for the pulp mill operations. This reporting requirement had less effect on the general statistics of mills primarily engaged in producing building paper and board than on those producing paperboard and paper, except building paper.

27 PRINTING, PUBLISHING, AND ALLIED INDUSTRIES

This major group includes establishments engaged in printing by one or more of the common processes, such as letterpress, lithography, gravure, or screen; and those establishments which perform services for the printing trade, such as bookbinding, typesetting, engraving, photoengraving, and electrotyping. This major group also includes establishments engaged in publishing newspapers, books, and periodicals, whether or not they do their own printing. News syndicates are classified in service industries, and textile printing and finishing in Major Group 22.

271 NEWSPAPERS: PUBLISHING, PUBLISHING AND PRINTING:

2711 Newspapers: Publishing, Publishing and Printing (S-96; C-100).—Establishments primarily engaged in publishing newspapers, or in publishing and printing newspapers. These establishments carry on the various operations necessary for issuing newspapers, including the gathering of news, and the preparation of editorials and advertisements, but may or may not perform their own printing. Commercial printing is frequently carried on by establishments engaged in publishing and printing newspapers, but even though the commercial printing may be of major importance such establishments are included in this industry.

Establishments not engaged in publishing newspapers, but which print or lithograph newspapers for publishers, are classified in industry 2751 or industry 2752. News syndicates are classified in service industries. Establishments primarily engaged in publishing shopping news are classified in industry 2741.

Publications have been classified as periodicals (industry 2721) rather than as newspapers if their news and editorial presentations are not typically directed to the public at large. Where the news is of general interest publications are considered periodicals if they are not the primary printed source of such news. Among the types of publications sometimes considered newspapers, but treated in the census as periodicals, are the following: trade journals; house organs, local church or school papers, and like publications with very limited or specialized news treatment. Generally, publications issued by nonprofit organizations (educational, religious, charitable, labor, business, professional, etc.) are classified as periodicals, as are magazine and comic supplements for Sunday newspapers.

272 PERIODICALS: PUBLISHING, PUBLISHING AND PRINTING:

2721 Periodicals: Publishing, Publishing and Printing (S-89; C-96).—Establishments primarily engaged in publishing periodicals, or in preparing, publishing, and printing periodicals. These establishments carry on the various operations necessary for issuing periodicals, but may or may not perform their own printing. Establishments not engaged in publishing periodicals, but which print periodicals for publishers, are classified in industry 2751 or industry 2752.

Data on the periodical publishing activities of nonprofit organizations (religious, educational, social, charitable, etc.) have been included to the extent that the employees of such organizations were covered under the Social Security System.

273 BOOKS:

2731 Books: Publishing, Publishing and Printing (S-93; C-88).—Establishments primarily engaged in publishing only, or in publishing and printing books and pamphlets. Establishments primarily engaged in printing, or in printing and binding (but not publishing) books and pamphlets are classified in industry 2732.

Industry 2731 also includes data on book publishing activities obtained from nonprofit organizations whose employees are covered under the Social Security System and were able to report their book publishing operations as a separate establishment.

2732 Book Printing (S-78; C-69).—Establishments primarily engaged in printing only or in printing and binding books and pamphlets, but not in publishing. Establishments primarily engaged in publishing, or in publishing and printing books and pamphlets, are classified in industry 2731. Establishments engaged in both printing and binding books, but primarily binding books printed elsewhere, are classified in industry 2789.

Establishments classified in industry 2732 are similar in character to some establishments primarily engaged in commercial letterpress printing (industry 2751) and in commercial lithography (industry 2752). The distinction is that the establishments classified in industry 2732 derive the greater part of their revenue from printing books and pamphlets, while such operations are secondary activities for establishments classified in industries 2751 and 2752.

274 MISCELLANEOUS PUBLISHING:

2741 Miscellaneous Publishing (S-92; C-84).—Establishments primarily engaged in miscellaneous publishing activities, n.e.c., whether or not engaged in printing. Establishments primarily engaged in offering financial, credit, or other business services and which may publish directories as part of this service are not included in this industry but are classified in service industries.

This industry comprises establishments primarily engaged in publishing such products as maps, atlases, sheet music, directories, almanacs, catalogs, globe covers, racing forms, and shopping news or engaged in miscellaneous publishing activities, n.e.c., whether or not engaged in printing. Establishments primarily engaged in printing such products and not engaged in publishing are classified in industry 2751, or industry 2752, depending on the primary printing process employed. Establishments primarily engaged in publishing greeting cards are classfied in industry 2771.

275 COMMERCIAL PRINTING:

2751 Commercial Printing, Except Lithographic (S-86; C-79).—Establishments primarily engaged in commercial or job printing, except lithographic. This industry includes general printing shops, as well as shops specializing in printing newspapers and periodicals for others, and those which specialize in gravure, rotogravure, and screen process printing. Establishments primarily engaged in printing books, without publishing, are classified in industry 2732, and greeting cards in industry 2771. Establishments primarily engaged in printing from lithographic plates are classified in industry 2752.

2752 Commercial Printing, Lithographic (S-80; C-82).—Establishments primarily engaged in printing by the lithographic process. The greater part of the work in this industry is performed on a job or custom basis; but in some cases lithographed calendars, maps, posters, decalcomanias, etc., are made for sale. Offset printing, photo-offset printing, and photolithographing are also included in this industry. Establishments primarily engaged in lithographing books and pamphlets, without publishing, are classified in industry 2732, and greeting cards in industry 2771.

2753 Engraving and Plate Printing (S-89; C-79).—Establishments primarily engaged in engraving and etching steel, copper, wood, or rubber plates; in using these plates to print stationary, visiting and other cards, invitations, maps, etc.; and in making woodcuts for use in printing illustrations, posters, etc. Engraving for purposes other than printing is classified in industry 3479. Establishments primarily engaged in preparing photoengraved plates (halftones and linecuts) are classified in industry 2793.

276 MANIFOLD BUSINESS FORMS:

2761 Manifold Business Forms (S-90; C-91).—Establishments primarily engaged in designing and printing, by any process, special forms for use in the operation of a business, in single and multiple sets, including carbonized or interleaved with carbon or otherwise processed for multiple reproduction. The principal types of manifold business forms are continuous, unit-set, and salesbooks.

277 GREETING CARD PUBLISHING:

2771 Greeting Card Publishing (S-92; C-96).—Establishments primarily engaged in designing, publishing and printing by any process of greeting cards for all occasions.

278 BOOKBINDING AND RELATED INDUSTRIES:

2782 Blankbooks; Loose Leaf Binders and Devices (S-88; C-88).—Establishments primarily engaged in manufacturing blankbooks, loose leaf devices, and library binders.

2789 Bookbinding, and Related Work (S-95; C-83).—Establishments primarily engaged in edition, trade, job, and library bookbinding, in book or paper bronzing, gilding, and edging; in map and sample mounting; and other services related to bookbinding. Establishments primarily binding books printed elsewhere are classified in this industry, but those primarily binding books printed in the same establishment are classified in industry Group 273.

279 SERVICE INDUSTRIES FOR THE PRINTING TRADE:

2791 Typesetting (S-95; C-90).—Establishments primarily engaged in machine and hand typesetting for the trade, and in advertising typography.

2793 Photoengraving (S-95; C-91).—Establishments primarily engaged in preparing photoengraved plates (halftones and linecuts). These establishments do not, as a rule, print from the plates which they make, but prepare them for use by others.

2794 Electrotyping and Stereotyping (S-87; C-86).—Establishments primarily engaged in preparing electratype and stereatype plates. These establishments do not, as a rule, print from the plates which they make, but prepare them for use by others.

28 CHEMICALS AND ALLIED PRODUCTS

This major group includes establishments producing basic chemicals, and establishments manufacturing products by predominantly chemical processes. Establishments classified in this major group manufacture three general classes of products: (1) basic chemicals such as acids, alkalies, salts, and organic chemicals; (2) chemical products to be used in further manufacture such as synthetic fibers, plastics materials, dry colors, and pigments; (3) finished chemical products to be used for ultimate consumption such as drugs, cosmetics, and soaps; or to be used as materials or supplies in other industries such as paints, fertilizers, and explosives. The mining of natural rock salt is classified in mining industries. Establishments primarily engaged in manufacturing nonferrous metals and high percentage ferroalloys are classified in Major Group 33; silicon carbide in Major Group 32; baking powder, other leavening compounds, and starches in Major Group 20; and embalming fluids and artists' colors in Major Group 39. Establishments primarily engaged in packaging, repackaging, and bottling of purchased chemical products, but not engaged in manufacturing chemicals and allied products, are classified in trade industries.

281 INDUSTRIAL INORGANIC AND ORGANIC CHEMICALS:

2812 Alkalies and chlorine (S-66; C-79).—Establishments primarily engaged in manufacturing sodium hydroxide (caustic soda), potassium hydroxide (caustic potash), soda ash, potassium carbonate, sodium bicarbonate, sal soda, and chlorine. Establishments

primarily engaged in manufacturing ammonium compounds or alkali metals are classified in industry 2819, and plants primarily engaged in mining natural potassium or sodium alkalies are classified in SIC industry 1474.

2813 Industrial Gases (S-98; C-87).—Establishments primarily engaged in manufacturing gases for sale in compressed, liquid, and solid forms. Establishments primarily engaged in manufacturing fluorine, ammonia, and sulfur dioxide are classified in industry 2819; and chlorine in industry 2812. Distributors of industrial gases and establishments primarily engaged in shipping liquid oxygen are classified in trade. Natural gasoline plants engaged in the production of gases in compressed and liquefied form are classified in mining industries, and petroleum refineries producing these gases in industry 2911.

2815 Cyclic Intermediates, Dyes, Organic Pigments (Lakes and Toners), and Cyclic (Coal Tar) Crudes (S-69; C-65).—Establishments primarily engaged in manufacturing cyclic organic intermediates, dyes, color lakes and toners, and coal tar crudes. Important products of this industry include: (1) derivatives of benzene, toluene, naphthalene, anthracene, pyridine, carbazole, and other cyclic chemical products; (2) synthetic organic dyes; (3) synthetic organic pigments; and (4) cyclic (coal tar) crudes, such as light oils and light oil products; coal tar acids; and products of medium and heavy oil such as creosote oil, naphthalene, anthracene, and their higher homologues, and tar. Establishments primarily engaged in manufacturing coal tar crudes in chemical recovery ovens are classified in industry 3312, and petroleum refineries which produce such products in industry 2911.

This industry combined two industries that were separate under the previous classification system: industry 2814, Cyclic (coal tar) crudes and industry 2815, Dyes, dye (cyclics) intermediates, and organic pigments (lakes and toners).

2816 Inorganic Pigments (S-91; C-87).—Establishments primarily engaged in manufacturing inorganic pigments. Important products of this industry include black pigments (except carbon black, industry 2895), white pigments and color pigments. Organic color pigments are classified in industry 2815.

2818 Industrial Organic Chemicals, N.E.C. (S-72; C-81).—Establishments primarily engaged in manufacturing industrial organic chemicals, n.e.c. Important products of this industry include: (1) noncyclic organic chemicals such as acetic, chloroacetic, adipic, formic, oxalic and tartaric acids and their metallic salts; chloral, formaldehyde and methylamine; (2) solvents such as amyl, butyl and ethyl alcohols; methanol; amyl, butyl and ethyl acetates; ethyl ether, ethylene glycol ether and diethylene glycol ether; acetone, carbon disulfide and chlorinated solvents such as carbon tetrachloride, perchloroethylene and trichloroethylene; (3) polyhydric alcohols such as ethylene glycol, sorbitol, pentaerythritol; (4) synthetic perfume and flavoring materials such as coumarin, methyl salicylate, saccharin, citral, citronellol, synthetic geraniol, ionone, terpineol, and synthetic vanillin; (5) rubber processing chemicals such as accelerators and antioxidants, both cyclic and acyclic; (6) plasticizers, both cylic and acyclic, such as esters of phosphoric acid, phthalic anhydride, adipic acid, lauric acid, oleic acid, sebacic acid, and stearic acid; (7) synthetic tanning agents such as naphthalene sulfonic acid condensates; (8) chemical warfare gases; and (9) esters, amines, etc. of polyhydric alcohols and fatty and other acids. Establishments primarily engaged in manufacturing plastic materials and nonvulcanizable elastomers are classified in industry 2821; synthetic rubber in industry 2822; essential oils in industry 2899; wood distillation products, naval stores, and natural dyeing and tanning materials in Industry Group 286; rayon and other synthetic fibers in industries 2823 and 2824; specialty cleaning, polishing and sanitation preparations in industry 2842; and paints and pigments in Industry Group 285. Distillaries engaged in the manufacture of grain alcohol for beverage purposes are classified in industry 2085.

2819 Industrial Inorganic Chemicals, N.E.C. (S-88; C-74)[8].—Establishments primarily engaged in manufacturing industrial inorganic chemicals, n.e.c. Important products of this industry include inorganic salts of sodium (excluding refined sodium chloride), potassium, aluminum, calcium, chromium, magnesium, mercury, nickel, silver, tin; inorganic compounds such as alums, calcium carbide, hydrogen peroxide, phosphates, sodium silicate, ammonia compounds and anhydrous ammonia; fertilizer materials such as muriate and sulfate of potash; rare earth metal salts and elementol bromine, fluorine, iodine, phosphorous, and alkali metals (sodium, potassium, lithium, etc.).

282 PLASTICS MATERIALS AND SYNTHETIC RESINS, SYNTHETIC RUBBER, SYNTHETIC AND OTHER MAN-MADE FIBERS, EXCEPT GLASS:

2821 Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers (S-84; C-64).—Establishments primarily engaged in manufacturing synthetic resins, plastics materials, and nonvulcanizable elastomers. Important products of this industry include: cellulose plastic materials; phenolic and other tar acid resins; urea and melamine resins; vinyl resins; styrene resins; alkyd resins; acrylic resins; polyethylene resins; rosin modified resins; coumarone-indene and petroleum polymer resins; and miscellaneous resins, including polyamid resins, silicones, polyisobutylenes, polyesters; vulcanized fiber; casein plastics; and regenerated cellulose. This classification does not include nonchemical manufacturers who merely purchase resin or plastics materials to produce fabricated plastics products, film, and sheets, classified in industry 3079.

2822 Synthetic Rubber (Vulcanizable Elastomers) (S-92; C-80).—Establishments primarily engaged in manufacturing synthetic rubber by polymerization or copolymerization. An elastomer for the purpose of this classification is a rubber-like material capable of vulcanization, such as copolymers of butadiene and styrene, or butadiene and acrylonitrile, polybutadienes, chloraprene rubbers, and isobutylene-isoprene copolymers. Butadiene copolymers containing less than 50% butadiene are classified in industry 2821. Chlorinated rubber and cyclized rubbers are considered as semifinished products, and are classified in industry 3069.

2823 Cellulosic Man-Made Fibers (S-D; C-D).—Establishments primarily engaged in manufacturing cellulosic fibers (including cellulose acetate and regenerated cellulose such as rayon by the viscose or cuprammonium process) in the form of manofilament, yarn, staple or tow suitable for further manufacturing on spindles, looms, knitting machines or other textile processing equipment. Establishments primarily engaged in manufacturing textile glass fibers are classified in industry 3229.

2824 Synthetic Organic Fibers, Except Cellulosic (S-95; C-97).—Establishments primarily engaged in manufacturing synthetic organic fibers except cellulosic (including those of regenerated proteins, and of polymers or copolymers of such components as vinyl chloride, vinylidene chloride, linear esters, vinyl alcohols, acrylonitrile, ethylenes, amides, and related polymeric materials) in the form of monofilament, yarn, staple or tow suitable for further manufacturing on spindles, looms, knitting machines or other textile processing equipment. Establishments primarily engaged in manufacturing textile glass fibers are classified in industry 3229.

283 DRUGS:

2831 Biological Products (S-88; C-45).—Establishments primarily engaged in the production of bacterial and virus vaccines, toxoids and analogous products (such as allergenic extracts), serums, plasmas, and other blood derivatives for human or veterinary use. Excluded are the activities of the American Red Cross, hospitals and other institutions which are important collectors of blood and producers of blood products.

2833 Medicinal Chemicals and Botanical Products (S-71; C-47).—Establishments primarily engaged in (1) manufacturing bulk organic and inorganic chemicals and their derivatives; and (2) processing (grading, grinding, and milling) bulk botanical drugs and herbs. Establishments primarily engaged in manufacturing agar-agar and similar products of natural origin, endocrine products, manufacturing or isolating basic vitamins, and isolating active medicinal principles such as alkaloids from botanical drugs and herbs are also included in this industry. Establishments primarily engaged in manufacturing reagent and chemically pure grades (other than United States Pharmacopoeia or National Formulary) of inorganic and organic chemicals are classified in industries 2819 and 2818, respectively.

2834 Pharmaceutical Preparations (S-87; C-94).—Establishments primarily engaged in manufacturing, fabricating, or processing drugs into pharmaceutical preparations for human or veterinary use. The greater part of the products of these establishments are finished in the form intended for final consumption, such as tablets, capsules, ointments, solutions and suspensions. Products of this industry consist of two important lines, namely, (1) pharmaceutical preparations primarily advertised or otherwise promoted to or prescribed by the health professions: medical, dental, pharmaceutical, nursing, etc.; and (2) pharmaceutical preparations primarily advertised or otherwise promoted to the general public. Establishments compounding drugs and medicines and selling these "over the counter" are classified in trade industries.

284 SOAP, DETERGENTS AND CLEANING PREPARATIONS, PERFUMES, COSMETICS, AND OTHER TOILET PREPARATIONS:

2841 Soap and Other Detergents, Except Specialty Cleaners (S-82; C-92).—Establishments primarily engaged in manufacturing soap, synthetic organic detergents, inorganic alkaline detergents, or any combination thereof, and establishments producing crude and refined glycerine from vegetable and animal fats and oils. Establishments primarily engaged in manufacturing shampoos or shaving products, whether from soap or synthetic detergents, are classified in industry 2844; and synthetic glycerin in industry 2818.

2842 Specialty Cleaning, Polishing, and Sanitation Preparations, Except Soap and Detergents (S-82; C-72).—Establishments primarily engaged in the manufacture of furniture and automobile body polish and cleaners, floor polish and shoe polishes and cleaners; dressings and finishes for fabricated leather and other materials; household insecticides and repellants and industrial exterminants; household, institutional, and industrial plant disinfectants and deodorants; fabric softeners and laundry starch preparations; and other sanitation preparations.

2843 Surface Active Agents, Finishing Agents, Sulfonated Oils and Assistants (S-80; C-47).—Establishments primarily engaged in producing surface active preparations for use as wetting agents, emulsifiers, and penetrants. Establishments engaged in producing sulfonated oils and fats and related products are also included.

2844 Perfumes, Cosmetics, and Other Toilet Preparations (S-91; C-84).—Establishments primarily engaged in manufacturing perfumes (natural and synthetic), cosmetics, and other toilet preparations. This industry also includes establishments primarily engaged in blending and compounding perfume bases; and those manufacturing shampoos and shaving products, whether from soap or synthetic detergents. Establishments primarily engaged in manufacturing synthetic perfume and flavoring materials are classified in industry 2818, and essential oils in industry 2899.

285 PAINTS, VARNISHES, LACQUERS, ENAMELS, AND ALLIED PRODUCTS:

2851 Paints, Varnished, Lacquers, and Enamels, and Allied Products (S-95; C-96).—Establishments primarily engaged in the manufacture of paints (in paste and ready-mixed form), varnishes, lacquers, enamels, and shellac; puttles and caulking compounds; wood fillers and sealers; paint and varnish removers; paint brush cleaners, and allied paint products.

The code number for this industry in the Standard Industrial Classification Manual is unchanged, but the content of the industry has been slightly changed from the classification system used in 1958. The change in the composition of the industry as now constituted, compared with that under the classification system followed in the 1958 census, is due principally to the inclusion of industry 2852 in 1963.

286 GUM AND WOOD CHEMICALS:

2861 Gum and Wood Chemicals (S-74, C-77).—Establishments primarily engaged in manufacturing hardwood and softwood distillation products, wood and gum naval stores, charcoal, natural dyestuffs, and natural tanning materials, tall oil and rosin, and rosin acid products. Establishments primarily engaged in manufacturing synthetic tanning materials are classified in industry 2818, synthetic dyes in industry 2815, and synthetic organic chemicals in industry 2818.

287 AGRICULTURAL CHEMICALS:

2871 Fertilizers (S-89; C-97).—Establishments primarily engaged in manufacturing mixed fertilizers (mixtures containing nitrogen, phosphoric acid (P_2O_5) or potash), from one or more fertilizer materials produced in the same establishment. Sulfuric, phosphoric, and nitric acid plants operated in conjunction with fertilizer plants and separately reported are classified in industry 2819. When separate reports are not available these acid plants are classified in this industry. Establishments engaged in manufacturing urea are classified in industry 2818. Establishments primarily engaged in mining, milling, or otherwise preparing natural potassium, sodium, or boron compounds (other than common salt) are classified in industry 1474. Establishments primarily engaged in manufacturing mixed fertilizers from purchased fertilizer materials are classified in industry 2872.

2872 Fertilizers, Mixing Only (S-94; C-96).—Establishments primarily engaged in mixing fertilizers from purchased fertilizer materials. Establishments primarily engaged in bulk blending of purchased fertilizer materials mostly for sale directly to the consumer are classified in retail trade.

2879 Agricultural Pesticides and other Agricultural Chemicals, N.E.C. (S-87; C-69).—Establishments primarily engaged in the formulation and preparation of ready-to-use agricultural pest control chemicals, including insecticides, fungicides, rodenticides, and herbicides from technical chemicals and concentrates, and the manufacture and formulation of miscellaneous agricultural chemicals, n.e.c., such as minor or trace elements, soil conditioners, etc.

Establishments primarily engaged in manufacturing basic or technical agricultural pest control chemicals including insecticides, fungicides, rodenticides and herbicides, such as lead and calcium arsenates, copper sulfate, DDT, BHC, 2, 4- D, carbonates, etc. are classified in Industry Group 281. Establishments primarily engaged in the production of household pesticides are classified in industry 2842, while establishments primarily engaged in manufacturing agricultural lime products are classified in Major Group 32.

The industry code 2879 for 1963 represents a change from the classification structure existing in 1958. In 1963 the industry combines two 1958 industries: 2873 and 2879.

289 MISCELLANEOUS CHEMICAL PRODUCTS:

2891 Adhesives and Gelatin (S-83; C- 2).—Establishments primarily engaged in manufacturing industrial and household adhesives, glues, sizes, and cements from vegetable, animal, or purchased synthetic resins. Establishments primarily engaged in manufacturing dessert preparations based on gelatin are classified in Industry 2099; vegetable gelatin or agar-agar in industry 2833; rubber cement in industry 3069; and asbestos cement in industry 3292.

2892 Explosives (S-88; C-94).—Establishments primarily engaged in manufacturing explosives such as sporting powder, blasting powder, high explosives, nitrated carbohydrates, safety fuses, and blasting and detonating caps. Included in this industry are government-owned plants operated by private firms for the account of the Federal Government. Establishments primarily engaged in manufacturing ammunition for small arms are classified in industry Group 196, and fireworks and pyrotechnics such as flares (all kinds) and railroad torpedoes, in industry 2899. Establishments primarily engaged in sheeting wells and also engaged in manufacturing nitroglycerine are included in the mineral industries.

2893 Printing Ink (S-93; C-92).—Establishments primarily engaged in manufacturing printing ink, gravure ink, screen process ink, and lithographic ink. Establishments primarily engaged in manufacturing writing and stamp pad inks are classified in industry 2899, and varnishes for printers' inks in industry 2851.

2895 Carbon Black (S-D; C-D).—Establishments primarily engaged in manufacturing carbon black (channel and furnace black). Establishments primarily engaged in manufacturing bone black and lamp black are classified in industry 2816.

2899 Chemical Preparations, N.E.C. (S-82; C-71).—Establishments primarily engaged in the manufacture of miscellaneous chemical preparations, n.e.c., such as essential oils, fireworks, automotive chemical specialties, and evaporated salt; industrial compounds, such as boiler and heat insulating compounds, metal, oil and water treating compounds, water proofing compounds and chemical supplies for foundries; fatty acids, such as stearic, oleic, fish and marine, cocanut-type fatty acids, and other unsaturated fatty acids fractionated from vegetable and animal oils and fats.

The code number for this industry in the Standard Industrial Classification Manual is unchanged, but the content of the industry has been slightly changed from the classification system used in 1958. The composition of the industry as now constituted, compared with that under the classification system followed in the 1958 census, is due principally to a change in definition of industry 2899 to include fatty acids and the subsequent reclassification of establishments formerly included in the old industry 2894, fatty acids, to industry 2899.

29 PETROLEUM REFINING AND RELATED INDUSTRIES

This major group includes establishments primarily engaged in petroleum refining, manufacturing paving and roofing materials, and compounding lubricating oils and greases from purchased materials. Establishments manufacturing and distributing gas to consumers are classified in public utilities industries, and those primarily engaged in producing coke and byproducts in Major Group 33.

291 PETROLEUM REFINING:

2911 Petroleum Refining (S-98; C-97).—Establishments primarily engaged in producing gasoline, kerosene, distillate fuel oils, residual fuel oils, lubricants and other products from crude petroleum, and its fractionation products through straight distillation of crude oil, redistillation of unfinished petroleum derivatives, cracking or other processes. Establishments primarily engaged in producing natural gasoline from natural gas are classified in mining industries. Those manufacturing lubricating oils are greases by blending and compounding purchased materials are included in industry 2992.

295 PAVING AND ROOFING MATERIALS:

2951 Paving Mixtures and Blocks (S-92; C-89).—Establishments primarily engaged in manufacturing asphalt and tar paving mixtures; and paving blocks made of asphalt, creosoted wood, and various compositions of asphalt or tar with other materials. Establish-

ments primarily engaged in manufacturing brick, concrete, granite, and stone paving blocks are classified in Major Group 32.

2952 Asphalt Felts and Coatings (S-90; C-92.—Establishments primarily engaged in manufacturing asphalt and other saturated roofing felts in roll or shingle form, either smooth or faced with grit, and in manufacturing roofing cements and coatings. Establishments primarily engaged in manufacturing paint are classified in industry 2851.

299 MISCELLANEOUS PRODUCTS OF PETROLEUM AND COAL:

2992 Lubricating Oils and Greases (S-91; C-33[10]).—Establishments primarily engaged in blending and compounding lubricating oils and greases from purchased mineral, animal, and vegetable materials. Petroleum refineries engaged in the production of lubricating oils and greases are classified in industry 2911.

2999 Products of Petroleum and Coal, N.E.C. (S-96; C-91).—Establishments primarily engaged in manufacturing fuel briquets, boulets, packaged fuel, pawdered fuel, and other products of petroleum and coal, n.e.c. Wood charcoal briquets are classified in industry 2861.

30 RUBBER AND MISCELLANEOUS PLASTICS PRODUCTS

This major group includes establishments manufacturing from natural, synthetic, or reclaimed rubber, gutta percha, balata, or gutta sisk, rubber products such as tires, rubber footwear, mechanical rubber goods, heels and soles, flooring, and rubber sundries. This group also includes establishments engaged in molding primary plastics for the trade, and manufacturing miscellaneous finished plastics products. The manufacture of elastic webbing is classified in Major Group 22; products made of elastic webbing and garments made from rubberized fabrics in Major Groups 23; synthetic rubber in industry 2822; and plastics materials in the form of sheets, rods, tubes, granules, powders, or liquids made from resins produced in the same establishment, in industry 2821.

301 TIRES AND INNER TUBES:

3011 Tires and Inner Tubes (S-D; C-99).—Establishments primarily engaged in manufacturing pneumatic casings, inner tubes, and solid and cushion tires for all types of vehicles, airplanes, farm equipment, and children's vehicles, as well as tire repair, and tire retreading (camelback) materials.

302 RUBBER FOOTWEAR:

3021 Rubber Footwear (S-93; C-90).—Establishments primarily engaged in manufacturing all-rubber footwear, waterproof fabric upper footwear, and other fabric upper footwear having rubber soles vulcanized to the uppers. Establishments primarily engaged in manufacturing rubber, composition, and fiber heels, soles, soling strips and related shoe making and repairing materials are classified in industry 3069.

303 RECLAIMED RUBBER:

3031 Reclaimed Rubber (S-D; C-77).—Establishments primarily engaged in reclaiming rubber from used tires, scrap, and miscellaneous waste rubber articles by processes which result in a devulcanized, depolymerized, or regenerated, replasticized product containing added ingredients. This product is sold for use as a raw material in the manufacture of rubber goods with or without a mixture with natural or synthetic rubber. Establishments primarily engaged in the assembly and wholesale of scrap rubber are classified in trade industries.

306 FABRICATED RUBBER PRODUCTS, N.E.C.:

3069 Fabricated Rubber Products, N.E.C. (S-86; C-89).—Establishments primarily engaged in manufacturing industrial and mechanical rubber goods, rubberized fabrics and vulcanized rubber clothing, and miscellaneous rubber specialties and sundries. Establishments primarily engaged in rebuilding and retreading tires are classified in industry 7534, that is, in nonmanufacturing.

307 MISCELLANEOUS PLASTICS PRODUCTS:

3079 Miscellaneous Plastics Products (S-92; C-80).—Establishments primarily engaged in molding primary plastics for the trade, in manufacturing film, sheets, sheeting, rods, tubes, and other stock shapes from purchased resins, and in fabricating miscellaneous finished plastics products. Establishments primarily engaged in manufacturing plastics materials in the form of sheets, rods, tubes, granules, powders, or liquids made from resins produced in the same establishment are classified in industry 2821, and those primarily engaged in manufacturing artificial leather in industry 2295.

31 LEATHER AND LEATHER PRODUCTS

This major group includes establishments engaged in tanning, currying, and finishing hides and skins, and establishments manufacturing finished leather and artificial leather products and some similar products made of other materials. Leather convertors are also included; such converters purchase hides and skins and have them processed into leather on a contract basis by others.

311 LEATHER TANNING AND FINISHING:

3111 Leather Tanning and Finishing (S-99; C-100).—Establishments primarily engaged in tanning, currying, and finishing hides and skins into leather. Leather converters are classified in this industry.

312 INDUSTRIAL LEATHER BELTING AND PACKING:

3121 Industrial Leather Belting and Packing (S-89; C-84).—Establishments primarily engaged in manufacturing industrial leather products, such as transmission belting, mechanical packings, and textile leathers. Establishments primarily engaged in manufacturing leather gaskets are classified in industry 3293; rubber belting and packing are included in industry 3069; plastic belting and packing in industry 3079; and metallic packing in industry 3599.

313 BOOT AND SHOE CUT STOCK AND FINDINGS:

3131 Boot and Shoe Cut Stock and Findings (S-93; C-94).—Establishments primarily engaged in manufacturing leather soles, inner soles, and other boot and shoe cut stock and findings. This industry also includes finished wood heels. Establishments primarily engaged in manufacturing heels, soling strips, and soles made of rubber, composition, plastics, and fiber are classified in Major Group 30.

314 FOOTWEAR, EXCEPT RUBBER:

3141 Footwear, Except House Slippers and Rubber Footwear (S-99; C-99).—Establishments primarily engaged in the production of boots and shoes designed primarily for street, work, play, or sport wear. Establishments primarily engaged in the production of such protective footwear as rubbers, rubber boots, storm shoes, goloshes, and other footwear with rubber soles vulcanized to the uppers are classified in industry 3021; and house slippers in industry 3142. Footwear made by custom boot makers is covered in the census of business.

3142 House Slippers (S-90; C-85).—Establishments manufacturing house slippers of leather or other materials, except as noted. Establishments primarily engaged in making vulcanized rubber slippers (beach and shower slippers, scuffs, etc.) are classified in industry 3021; wooden slippers including wooden clogs are classified in industry 2499; and paper both slippers in industry 2649. Knitting mills producing slipper socks are classified in industry 2252.

315 LEATHER GLOVES AND MITTENS:

3151 Leather Gloves and Mittens (S-81; C-89).—Establishments primarily engaged in manufacturing dress, semidress, and work gloves exclusively of leather or leather with lining of other material. Establishments primarily engaged in manufacturing sporting and athletic gloves are classified in industry 3949; knit gloves in industry 2259; and dress, semidress, and work gloves and mittens of cloth, or cloth and leather combined, in industry 2381.

316 LUGGAGE:

3161 Luggage (S-95; C-94).—Establishments primarily engaged in manufacturing luggage of leather or other materials. Among the products included in this industry are suitcases, briefcases, trunks, hat boxes (except paper or paperboard), and camera and binocular cases. Establishments primarily engaged in manufacturing luggage hardware are classified in industry 3429.

317 HANDBAGS AND OTHER PERSONAL LEATHER GOODS:

3171 Women's Handbags and Purses (S-98; C-98).—Establishments primarily engaged in manufacturing women's handbags and purses of leather or other materials, except precious metal (industry 3911).

3172 Personal Leather Goods, Except Handbags and Purses (S-96; C-92).—Establishments primarily engaged in manufacturing small articles such as billfolds, keycases, and coin purses of leather or other materials, except precious metal (industry 3911).

319 LEATHER GOODS, N.E.C.:

3191 Leather Goods N.E.C. (S-94; C-82).—Establishments primarily engaged in manufacturing leather goods, n.e.c., such as saddlery, harness, and whips; embossed leather goods; leather desk sets; and razor straps.

Establishments primarily engaged in manufacturing leather garments are classified in industry 2386; leather belts in industry 2387; leather gaskets in industry 3293; leather buffing and polishing wheels in industry 3291; and leather costume jewelry in industry 3691.

32 STONE, CLAY, AND GLASS PRODUCTS

This major group includes establishments engaged in manufacturing flat glass and other glass products, cement, structural clay products, pottery, concrete and gypsum products, cut stone products, abrasive and asbestos products, etc., from materials taken principally from the earth in the form of stone, clay, and sand. When separate reports are available for mines and quarries operated by manufacturing establishments classified in this major group, the mining activities are classified in mining industries; when separate reports are not available, the mining activities are classified with the manufacturing operations and classified herein.

321 FLAT GLASS:

3211 Flat Glass (S-90[1]; C-D).—Establishments primarily engaged in manufacturing flat glass, including plate glass, clear window glass, rolled glass, figured and wire glass, opalescent and obscured glass, and cathedral and skylight glass. This industry also includes establishments that produce laminated glass from glass produced in the same establishment. Establishments primarily engaged in manufacturing laminated glass from purchased flat glass are classified in industry 3231.

322 GLASS AND GLASSWARE, PRESSED OR BLOWN:

3221 Glass Containers (S-99; C-99).—Establishments primarily engaged in manufacturing glass containers for commercial packing and bottling, and for home canning. Products of this industry may be machine-made or hand-made and include ampoules, carboys, cosmetic jars, fruit jars, medicine bottles, milk bottles, vials, and beverage and beer bottles.

3229 Pressed and Blown Glass and Glassware, N.E.C. (S-96; C-97).—Establishments primarily engaged in manufacturing glass and glassware, n.e.c., pressed, blown, or shaped from glass produced in the same establishment. Establishments primarily engaged in manufacturing textile glass fibers are also included in this industry, but establishments primarily engaged in manufacturing glass wool insulation products are classified in industry 3296.

Establishments primarily engaged in the production of pressed lenses for headlights, beacons, and lanterns are also included in this industry, but establishments primarily engaged in the production of optical lenses are classified in industry 3831. Establishments primarily engaged in manufacturing glass containers are classified in industry 3221, and complete electric light bulbs in industry 3641.

323 GLASS PRODUCTS MADE OF PURCHASED GLASS:

3231 Glass Products Made of Purchased Glass (S-90[1]; C-D).—Establishments primarily engaged in manufacturing glass products from purchased glass, including laminated or safety glass, stained, leaded, ornamented, and decorated glass; mirrors; cutware; scientific apparatus glass; glass novelties; mosiac glass, round glass; cut, beveled, and etched glass; and glass watch crystals. Establishments primarily engaged in manufacturing optical lenses and ophthalmic lenses are classified in Major Group 38, Instruments and Related Products; glass fabrics in industry 2221; glass insulation in industry 3296; glass fishing rods in industry 3949.

324 CEMENT, HYDRAULIC:

3241 Cement, Hydraulic (S-99; C-100).—Establishments primarily engaged in manufacturing hydraulic cement, including portland natural, masonry, and puzzolan cements.

325 STRUCTURAL CLAY PRODUCTS:

3251 Brick and Structural Clay Tile (S-98; C-98).—Establishments primarily engaged in manufacturing clay building brick, vitrified paving brick and hollow structural tile. Establishments primarily engaged in manufacturing clay firebrick are classified in industry 3255; nonclay firebrick in industry 3297; sand lime brick in industry 3299; and glass brick in industry 3229.

3253 Ceramic Wall and Floor Tile (S-95; C-99).—Establishments primarily engaged in manufacturing ceramic mosaic tile, glazed wall tile, quarry tile, and other types of ceramic wall and floor tile. Establishments primarily engaged in manufacturing hollow structural tile and ceramic and salt glazed facing tile are classified in industry 3251; drain tile in industry 3259; asphalt floor tile in industry 3292; rubber tile in industry 3069; cork wall and floor tile in industry 2499; and other hard surface floor coverings in industry 3982. China and earthenware bathroom accessories (towel racks, soap cups, etc.) are classified in industry 3261.

3255 Clay Refractories (S-91; C-93).—Establishments primarily engaged in manufacturing clay firebrick, crucibles, and other heat-resisting clay products such as glass-house tank blocks, stoppers, floaters, and rings. Establishments primarily engaged in manufacturing nonclay refractories, as well as all graphite refractories whether of carbon bond or ceramic bond, are classified in industry 3297.

3259 Structural Clay Products, N.E.C. (S-89; C-95).—Establishments primarily engaged in manufacturing clay sewer pipe and kindred products made of clay, and structural clay products, n.e.c., such as architectural terra cotta, roofing tile, stove linings, flue lining, chimney pipes, thimbles and caps, wall coping, segment blocks, drain tile and adobe brick. Establishments primarily engaged in manufacturing concrete sewer pipe and classified in industry 3272; cast iron sewer pipe in industry 3321; and plastic pipe in industry 3079.

326 POTTERY AND RELATED PRODUCTS:

3261 Vitreous China Plumbing Fixtures and China and Earthware Fittings and Bathroom Accessories (S-97; C-97).—Establishments primarily engaged in manufacturing china plumbing fixtures and china and earthenware fittings and bathroom accessories.

3262 Vitreous China Table and Kitchen Articles (S-90; C-91).—Establishments primarily engaged in manufacturing vitreous china table and kitchen articles for use in households and in hotels, restaurants, and other commercial institutions for preparing, serving, or storing food or drink. Establishments primarily engaged in manufacturing fine (semivitreous) types of earthenware (whiteware) table and kitchen articles are classified in industry 3263.

3263 Fine Earthenware (Whiteware) Table and Kitchen Articles (S-92, C-91).—Establishments primarily engaged in manufacturing fine (semivitreous) types of earthenware table and kitchen articles for preparing, serving, or storing food or drink. Establishments primarily engaged in manufacturing vitreous china table and kitchen articles are classified in industry 3262.

3264 Porcelain Electrical Supplies (S-91; C-95).—Establishments primarily engaged in manufacturing porcelain electrical insulators, molded porcelain parts for electrical devices, steatite electrical products and other electrical supplies from clay and other ceramic materials.

3269 Pottery Products, N.E.C. (S-87; C-89).—Establishments primarily engaged in firing and decorating white china and earthenware for the trade and manufacturing art and ornamental pottery, industrial and laboratory pottery, stoneware and coarse earthenware table and kitchen articles, unglazed red earthenware florists' articles, and other pottery products, n.e.c.

327 CONCRETE, GYPSUM AND PLASTER PRODUCTS:

3271 Concrete Brick and Block (S-92, C-84).—Establishments primarily engaged in manufacturing concrete building blocks and brick from a combination of cement and aggregate. Contractors engaged in concrete construction work are classified in the construction industries, and building materials dealers primarily engaged in mixing and delivering ready mixed concrete in industry 3273.

3272 Concrete Products, Except Block and Brick (S-94; C-94).—Establishments primarily engaged in manufacturing concrete products, except block and brick, from a combination of cement and aggregate. Contractors engaged in concrete construction work are classified in the construction industries, and building materials dealers primarily engaged in mixing and delivering ready mixed concrete in industry 3273.

3273 Ready Mixed Concrete (S-92; C-98).—Establishments primarily engaged in manufacturing Portland cement concrete, manufactured and delivered to a purchaser in a plastic and unhardened state. This industry includes production and sale of central mixed concrete, shrink mixed concrete and transit mixed concrete.

3274 Lime (S-82; C-94).—Establishments primarily engaged in manufacturing quicklime, hydrated lime, and dead burned dolomite from limestone, dolomite shells, or other substances.

3275 Gypsum Products (S-97; C-98).—Establishments primarily engaged in manufacturing plaster, plasterboard, and other products composed wholly or chiefly of gypsum.

328 CUT STONE AND STONE PRODUCTS:

3281 Cut Stone and Stone Products (S-94; C-99).—Establishments primarily engaged in cutting, shaping, and finishing marble, granite, slate, and other stone for building and miscellaneous uses. Establishments primarily engaged in buying or selling partly finished monuments and tombstones, but performing no work on the stones other than lettering, finishing, or shaping to custom order, are classified in trade industries. The cutting of grindstones, pulpstones, and whetstones at the quarry is classified in mining industries.

329 ABRASIVE, ASBESTOS, AND MISCELLANEOUS NONMETALLIC MINERAL PRODUCTS:

3291 Abrasive Products (S-70[1]; C-95).—Establishments primarily engaged in manufacturing abrasive grinding wheels of natural or synthetic

materials, and other abrasive products. The cutting of grindstones, pulpstones, and whetstones at the quarry is classified in mining industries.

3292 Asbestos Products (S-95; C-91).—Establishments primarily engaged in manufacturing asbestos textiles, asbestos frictian materials, vinyl asbestas floar tile and ather cammadities composed wholly ar chiefly of asbestas, except asbestos paper (industry 2661), steam and ather packing, pipe and boiler cavering, and gaskets (industry 3293).

3293 Gaskets, Packing, and Asbestos Insulations (S-81; C-78).—Establishments primarily enganged in manufacturing packing for steam, water, and ather pipe joints, and far engines, air compressors, etc.; gaskets; and asbastas insulating materials for covering boilers and pipes. Establishments primarily engaged in manufacturing leather packing are classified in industry 3121, rubber packing in industry 3069, metal packing in industry 3599, and mineral wool and insulation products in industry 3296.

3295 Minerals and Earths, Ground ar Otherwise Treated (S-94; C-86).—Establishments aperating without a mine and primarily engaged in crushing, grinding, putverizing, ar atherwise preparing clay, ceramic, and refractary minerals (of the type in minerals Industry Group 145); barite (mined by industry 1472); miscellaneaus nanmetaltic minerals, except fuels (talc, gypsum, graphite, and ather minerals of the type classified in minerals Industry Graup 149); ar in crushing slag ar preparing roofing granules. However, establishments preparing such nanmetallic minerals ar roafing granules in conjunction with a mine at the site are classified in the mineral industries. The crushing and grinding of stane, the preparation of sand and gravel (minerals Industry Group 144) and af chemical and fertilizer minerals, except barite (minerals Industry Group 147, except industry 1472) are classified in the mineral industries whether or nat the establishment includes a mine. The beneficiation or preparatian af metalic ares and the cleaning and grading af coal at the time ar at separately aperated preparation plants are classified in the mineral industries.

The cade number for this Industry in the Standard Industrial Classificatian Manual is unchanged, but the content af the industry has been slightly changed fram the classificatian system used in 1958. The campasitian af the industry as naw canstituted, campared with that under the classificatian system fallawed in the 1958 census is due principally to (1) the reclassification of exfaliated vermiculite fram industry 3296 ta industry 3295 and (2) the inclusion of raofing granules praduced in canjunctian with mining aperatians in the minerat industries for 1963. In prior years these raofing granule plants were included in industry 3295.

3296 Mineral Waat (S-90; C-96).—Establishments primarily engaged in manufacturing mineral waal and mineral waal insulatian praducts made af such silicious materials as rock, slag, and glass, or cambinations thereaf. Establishments primarily engaged in manufacturing asbestas insulation products are classified in industries 3292 and 3293, textile glass fibers in industry 3229, and exfaliated vermiculite products in industry 3295. Exfaliated vermiculite was reclassified fram industry 3296 (in 1958) to industry 3295.

3297 Nonclay Refractaries (S-94; C-88).—Establishments primarily engaged in manufacturing refractars and crucibles made af materials other than clay. This industry also includes establishments primarily engaged in manufacturing all graphite refractaries, whether af carbon bond or ceramic bond. Establishments primarily engaged in manufacturing clay refractaries are classified in industry 3255.

3299 Nanmetallic Mineral Products, NEC (S-86; C-96).—Establishments primarily engaged in the factory production al statuary and art goods made of plaster af Paris and papier-maché and in manufacturing sand lime praducts, sheet mica products, and other nanmetallic mineral products, n.e.c.

33 PRIMARY METAL INDUSTRIES

This major graup includes establishments engaged in the smelting and refining of ferrous and nanferrous metals fram are, pig, or scrap; in the rolling, drawing, and alloying of ferrous and nanferrous metals; in the manufacture af castings, forgings, and ather basic products of ferraus and nanferrous metals; and in the manufacture af nails, spikes, and insulated wire and cable. This major graup alsa includes the praductian af cake.

331 BLAST FURNACES, STEEL WORKS, AND ROLLING AND FINISHING MILLS:

3312 Blast Furnaces (Including Cake Ovens), Steel Works and Rolling Mills (S; C)[12].—Establishments primarily engaged in manufacturing hat metat, pig iron, silvery pig iran, and ferraalloys fram iran ore and Iran and steel scrap; canverting pig iron, scrap iron and scrap steel into steel; and in hat rolling iron and steel Inta basic shapes such as plates, sheets, strips, rads, bars and tubing. Merchant blast firnaces and by-praduct ar beehive coke ovens are also included in this industry.

Included in this Industry ara all establishments engaged in the manufacture of blast furnace ferraallays. However, establishments which manufacture ferra or nanferraus additive allays by electrametallurgical process are classified in industry 3313. Also, establishments which draw wire fram purchased rad and bar; establishments which perform anly cald ralling, drawing ar finishing aperations; and establishments which produce welded, seamless, and heavy riveted pipe from purchased materials are nat included in industry 3312, but are included in industries 3315, 3316, and 3317, respectively.

3313 Electrometallurgical Products (S-85-90; C-77)[13].—Establishments primarily engaged in manufacturing ferro and nanferraus additive alloys by electrometallurgical processes, including high percentage ferraalloys and high percentage nanferraus additive allays. Ferroallays and other additives praduced in blast furnaces are included in industry 3312.

3315 Steel Wire Drawing and Steel Nails and Spikes (S-89; C-30)[13].—Establishments primarily engaged in drawing wire from purchased iron ar steel rods, bars, ar wire and which may be engaged in the further manufacture of products made fram wire; and those primarily engaged in manufacturing steel nails and spikes tram purchased materials. Rolling mills engaged in the production of ferrous wire from wire rods or hat ralled bars praduced in the same establishment are classified in industry 3312. Establishments primarily engaged in drawing nanferraus wire are classified in Industry Group 335.

3316 Cold Ralled Sheet, Strip, and Bars (S-94; C-20)[13].—Establishments primarily engaged in (1) cald ralling steel sheets and strip fram purchased hat ralled sheets; (2) cald drawing steel bars and steel shapes from purchased hat rolled steel bars; and (3) praducing ather cold finished steel. Establishments primarily engaged in the production af steel, including hat ralled steel sheets, and further cald ralling such sheets are included in industry 3312.

3317 Steel Pipe and Tubes (S-91; C-37).—Establishments primarily engaged in the praductian af welded or seamless steel pipe and heavy riveted steel pipe fram purchased materials. Establishments primarily engaged in the praductian af steel, including steel skelp ar steel blanks, tube rounds, or pierced bitlets are classified in industry 3312.

322 IRON AND STEEL FOUNDRIES:— This graup includes establishments primarily engaged in manufacturing iran and steel castings. These establishments generally operate an a jab ar arder basis, manufacturing castings far sale ta others ar far interplant transfer. Establishments which produce iran and steel castings and which are alsa engaged in fabricating aperatians such as machining, assembling, etc., in manufacturing a specified praduct are classified in the industry of the specified praduct. Iran and steel castings are made ta a considerable extent by establishments, classified in ather industries, that aperate foundry departments for the praductian af castings far incorporatian, in the same establishment, into such praducts as staves, furnaces, plumbing fixtures, matar vehicles, etc. Establishments primarily engaged in the manutacture and ralling at steel and alsa making steel castings are classified in industry 3312. Establishments primarily engaged in manufacturing nanferraus castings are classified in Industry Graup 336.

3321 Gray Iran Foundries (S-93; C-88). —Establishments primarily engaged in manufacturing gray iron castings, including cast iran pressure and soil pipe and fittings. Establishments primarily engaged in manufacturing valves and fittings, except plumbers' brass goods and fittings, are classified in industry 3494.

3322 Malleable Iran Foundries (S-87; C-87).—Establishments primarily engaged in manufacturing malleable iron castings.

3323 Steel Faundries (S-85; C-89).—Establishments primarily engaged in manufacturing steel castings.

333 PRIMARY SMELTING AND REFINING OF NONFERROUS METALS AND ALLOYS:

3331 Primary Smelting and Refining of Copper (S; C)[14].—Establishments primarily engaged in smelting copper from the are, and in refining copper by electrolytic ar other processes. Establishments primarily engaged in ralling, drawing ar extruding copper are classified in Industry 3351.

3332 Primary Smelting and Refining af Lead (S; C)[14].—Establishments primarily engaged in smelting lead fram the are and in refining lead by any process. Establishments primarily engaged in ralling, drawing, ar extruding lead are classified in industry 3356.

3333 Primary Smelting and Refining of Zinc (S-92; C-81[15]).—Establish-

ments primarily engaged in smelting zinc from the ore, and in refining zinc, by any process. Establishments primarily engaged in rolling, drawing or extruding zinc are classified in industry 3356.

3334 Primary Production of Aluminum (S-100; C-75[14]).—Establishments primarily engaged in producing aluminum from alumina, and in refining aluminum by any process. Establishments primarily engaged in rolling, drawing or extruding aluminum are classified in industry 3352.

3339 Primary Smelting and Refining of Nonferrous Metals, NEC (S-83; C-39[17]).—Establishments primarily engaged in smelting and refining nonferrous metals, n.e.c. Establishments primarily engaged in rolling, drawing, and extruding these nonferrous primary metals are classified in industry 3356, and the production of bullion and the site of the mine is classified in the mining industries.

334 SECONDARY SMELTING, REFINING, AND ALLOYING OF NONFERROUS METALS AND ALLOYS:

3341 Secondary Smelting and Refining of Nonferrous Metals (S-94; C-26[18]).—Establishments primarily engaged in recovering nonferrous metals and alloys from new and used scrap and dross, but which are not engaged in further fabrication. This industry includes establishments engaged in both the recovery and alloying of precious metals. Plants engaged in the recovery of tin through secondary smelting and refining, as well as by chemical processes, are included in this industry. Establishments primarily engaged in assembling, sorting, and breaking up scrap metal, without smelting and refining, are classified in trade industries.

335 ROLLING, DRAWING, AND EXTRUDING OF NONFERROUS METALS:

3351 Rolling, Drawing, and Extruding of Copper (S-90; C-91).—Establishments primarily engaged in rolling, drawing and extruding copper, brass, bronze and other copper-base alloy basic shapes such as plate, sheet, strip, bar, and tubing. Establishments primarily engaged in recovering copper and its alloys from scrap or dross are classified in industry 3341.

3352 Rolling, Drawing and Extruding of Aluminum (S-85; C-93[19]).—Establishments primarily engaged in rolling, drawing and extruding aluminum and aluminum-base alloy basic shapes such as plate, sheet, bar, tubing and foil.

3356 Rolling, Drawing and Extruding of Nonferrous Metals, Except Copper and Aluminum (S-84; C-81[20]).—Establishments primarily engaged in rolling, drawing and extruding nonferrous metals other than copper (industry 3351), and aluminum (industry 3352). The products of this industry are produced in the form of basic shapes, such as plate, sheet, strip, bar and tubing. Establishments primarily engaged in recovering nonferrous metals and alloys from scrap or dross are classified in industry 3341; in manufacturing gold, silver, tin and other foils, except aluminum, in industry 3497; and aluminum foil in industry 3352.

3357 Drawing and Insulating of Nonferrous Wire (S-99; C-86[21]).—Establishments primarily engaged in drawing, drawing and insulating, and insulating wire and cable of nonferrous metals from purchased wire bars, rods or wire.

336 NONFERROUS FOUNDRIES:

These foundry industries comprise establishments primarily engaged in manufacturing aluminum castings, including cast aluminum cooking utensils (3361), brass, bronze, and copper castings including unmachined bearings and bushings (3362), and other nonferrous castings (3369). Those primarily engaged in manufacturing iron and steel castings are classified in Industry Group 322.

For these industries, captive production (that is, the tonnage of castings produced for incorporation into the final product of the plant or company) is a particularly important factor. Distinction is made between rough castings and castings which are machined or further processed and incorporated into other products. The removal of gates, risers, sprues, and tumbling, dipping, and sand blastings do not constitute machining. Plants primarily engaged in manufacturing castings are included in the foundry industries; plants primarily engaged in further processing castings into parts for metal products or machinery are classified in other major groups.

For the 1963 and 1958 Censuses of Manufactures separate establishment reports were received from all commercial (jobbing) foundries and from those captive foundries which were operated as separate establishments by the reporting companies. These two groups comprise the types of establishments included in industries 3361, 3362, and 3369. However, where the captive foundry operation was completely integrated with the operations in the entire plant, no separate establishment report was received for the foundry activity. In these instances data were obtained on the tonnage of castings produced and consumed and on the number of employees usually engaged in the captive foundry operation. However, establishments with such foundry departments were classified on the basis of the plant's final product and accordingly the general statistics on employment, payroll, cost of materials, etc., are included in the data for such industries as 3432 and 3494, etc.

3361 Aluminum Castings (S-81; C-83).—Establishments primarily engaged in manufacturing castings and die castings of aluminum.

3362 Brass, Bronze, Copper, Copper-Base Alloy Castings (S-84; C-78).—Establishments primarily engaged in manufacturing castings and die castings of copper and copper-base alloy.

3369 Nonferrous Castings, N.E.C. (S-78; C-75).—Establishments primarily engaged in manufacturing castings and die castings of nonferrous materials except aluminum, copper and copper-base alloys.

339 MISCELLANEOUS PRIMARY METAL INDUSTRIES:

3391 Iron and Steel Forgings (S-89; C-69[22]).—Establishments primarily engaged in manufacturing light and heavy board drop, steam hammer, upset, and press iron and steel forgings with or without the use of dies. Rolling mills engaged in the production of iron and steel forgings are classified in Industry 3312.

3392 Nonferrous Forgings (S-69; C-55).—Establishments primarily engaged in manufacturing, with or without the use of dies, forgings of aluminum, titanium, copper and other nonferrous metals and alloys.

3399 Primary Metal Industries, N.E.C. (S-93; C-87).—Establishments primarily engaged in manufacturing primary metal products, n.e.c., such as nonferrous nails, brads, and spikes; metal powder, flakes, and paste; and establishments primarily engaged in heat treating of metal for the trade; also those establishments primarily engaged in reclaiming metallics from slag.

34 FABRICATED METAL PRODUCTS, EXCEPT ORDANCE, MACHINERY, AND TRANSPORTATION EQUIPMENT

This major group includes establishments engaged in fabricating ferrous and nonferrous metal products such as metal cans, tinware, hand tools, cutlery, general hardware, nonelectric heating apparatus, fabricated structural metal products, metal stampings, and a variety of metal and wire products, n.e.c. Certain important segments of the metal fabricating industries are classified in other major groups such as ordnance in Major Group 19; machinery in Major Groups 35 and 36; transportation equipment in Major Group 37; professional, scientific, and controlling instruments, watches and clocks in Major Group 38; and jewelry and silverware in Major Group 39. Establishments primarily engaged in processing ferrous and nonferrous metals and their alloys are classified in Major Group 33.

341 METAL CANS:

3411 Metal Cans (S-97; C-98).—Establishments primarily engaged in manufacturing metal cans from purchased tinplate, terneplate, blackplate, or enameled sheet metal. Establishments primarily engaged in the manufacture of composite cans made partially of metal and partly of nonmetallic materials (such as fiberboard) are excluded from this industry.

342 CUTLERY, HAND TOOLS, AND GENERAL HARDWARE:

3421 Cutlery (S-89; C-97).—Establishments primarily engaged in manufacturing cutlery. Establishments primarily engaged in manufacturing table cutlery made entirely of metal are classified in industry 3914; those manufacturing electric razors in industry 3634; and those manufacturing hair clippers for human use in industry 3999, and for animal use in industry 3222.

3423 Hand and Edge Tools, Except Machine Tools and Hand Saws (S-87; C-84).—Establishments primarily engaged in manufacturing files and other hand and edge tools for metalworking, woodworking, and general maintenance. Establishments primarily engaged in manufacturing saws are classified in industry 3425; and metal cutting dies and power driven hand tools, and attachments and accessories for machine tools in Major Group 35.

3425 Hand Saws and Saw Blades (S-78; C-85).—Establishments primarily engaged in manufacturing hand saws and saw blades for hand and power driven saws. Establishments primarily engaged in manufacturing power driven sawing machines are classified in Major Group 35.

3429 Hardware, N.E.C. (S-91; C-93).—Establishments primarily engaged in manufacturing miscellaneous metal products usually termed "hardware" and n.e.c. Establishments primarily engaged in manufacturing bolts and nuts are classified in industry 3452, nails and spikes in Major Group 33, cutlery in industry 3421, hand

tools in industry 3423, and pole line and transmission hardware in Major Group 36.

343 HEATING APPARATUS (EXCEPT ELECTRIC) AND PLUMBING FIXTURES:

3431 Enameled Iron and Metal Sanitary Ware (S-84; C-91).—Establishments primarily engaged in manufacturing enameled iron, cast iron, or pressed metal sanitary ware. Establishments primarily engaged in manufacturing vitreous and semivitreous pottery sanitary ware are classified in industry 3261; and those manufacturing porcelain enameled kitchen, household, and hospital ware in industry 3461.

This industry includes establishments which fall into two significantly different categories namely those producing cast iron plumbing fixtures and those producing metal fixtures of pressed metal. Accordingly, the manufacturing plants included in this industry involve different manufacturing processes depending upon the line of products produced. Those fixture plants producing cast iron fixtures include significant foundry operations while the pressed metal fixture plants are more closely allied to metal fabricating plants producing their product by forming processes (stamping, drawing, etc.).

The operations of the largest establishments in this industry cover the entire production process including the casting of the fixture through the machining, finishing, and assembly operations. In general these processes are carried on at a single manufacturing plant. However, in a few instances the foundry operations were performed at separate locations and, accordingly, those separate foundries were classified in the foundry industries (SIC industries 3321, 3322, 3323, 3361, 3362 and 3369). In the latter case the plants classified in this industry would be limited to machining and finishing operations on castings received from their associated plants.

3432 Plumbing Fixture Fittings and Trim (Brass Goods) (S-90; C-83).—Establishments primarily engaged in manufacturing plumbing fixture fittings and trim (brass goods). Establishments primarily engaged in the manufacture of steam or water line valves are classified in industry 3494.

3433 Heating Equipment, Except Electric (S-76; C-81).—Establishments primarily engaged in manufacturing heating equipment for all purposes other than paper, including all gas, oil, and stoker coal fired equipment for the automatic utilization of gaseous, liquid, and solid fuels. Establishments primarily engaged in manufacturing electric stoves and ranges are classified in industry 3631; boiler shops primarily engaged in the production of industrial, power and marine boilers in industry 3443; and industrial process furnaces and ovens in industry 3567.

344 FABRICATED STRUCTURAL METAL PRODUCTS:

3441 Fabricated Structural Steel (S-86; C-89).—Establishments primarily engaged in manufacturing fabricated iron and steel or other metal for structural purposes, for bridges, buildings, and sections for ships, boats and barges. Establishments primarily engaged in manufacturing metal doors, sash, frames, molding and trim are classified in industry 3442; and fabrication work done by construction contractors at the site of construction is classified in construction industries.

3442 Metal Doors, Sash, Frames, Molding and Trim (S-8; C-94).—Establishments primarily engaged in manufacutring ferrous and nonferrous metal and metal covered doors and sash, window and door frames and screens, molding and trim.

3443 Fabricated Plate Work (Boiler Shops) (S-89; C-83).—Establishments primarily engaged in manufacturing power and marine boilers, pressure and nonpressure tanks, processing and storage vessels, heat exchangers, weldment's and similar products by the process of cutting, forming and joining metal plates, shapes, bars, sheet, pipe mill products and tubing to custom or standard design for factory or field assembly. Establishments primarily engaged in manufacturing nonelectric heating aparatus other than power boilers are classified in industry 3433, and household cooking apparatus in industry 3631.

3444 Sheet Metal Work (S-88; C-78).—Establishments primarily engaged in manufacturing sheet metal work for buildings (not including fabrication work done by construction contractors at the place of construction), and manufacturing sheet metal stove pipes, light tanks, etc. Establishments in the sheet metal field are frequently engaged in activities which overlap the economic divisions of manufacturing, wholesale, service and construction, and some difficulty is experienced in distinguishing a sheet metal manufacturing establishment from other sheet metal wholesalers. Establishments performing manufacturing operations incidental to their installation or contracting business are excluded from the census of manufactures. Conversely, many of the plants included in industry 3444 are engaged to a secondary extent in wholesaling or installing sheet metal items.

3446 Architectural and Ornamental Metal Work (S-86; C-71).—Establishments primarily engaged in manufacturing architectural and ornamental metal work of ferrous and nonferrous metals, such as stairs and staircases, open steel flooring (grating), fire escapes, grills, railings, and fences and gates except wire. Establishments primarily engaged in manfacturing prefabricated and portable metal buildings and parts, and miscellaneous metal work are classified in industry 3449.

This industry was not defined in the SIC for 1958 but was then part of industry 3449.

3449 Miscellaneous Metal Work (S-89; C-68).—Establishments primarily engaged in manufacturing miscellaneous ferrous and nonferrous metal work, such as prefabricated and portable metal buildings and parts, metal plaster bases, fabricated bar joists and concrete reinforcing bars, and prefabricated exterior metal panels.

This industry as redefined in the SIC for 1963, Industry 3446, shown above, was part of industry 3449 in 1958.

345 SCREW MACHINE PRODUCTS AND BOLTS, NUTS, SCREWS, RIVETS AND WASHERS:

3451 Screw Machine Products (S-97; C-90).—Establishments primarily engaged in manufacturing automatic or hand screw machine products from rod, bar, or tube stock of metal, fiber, plastics, or other material. The products of this industry consist of a wide variety of unassembled parts and are usually manufactured on a lot or order basis. Establishments primarily engaged in manufacturing standard bolts, nuts, rivets, screws, or other industrial fasteners, on headers, threaders, and nut forming machines are classified in industry 3452.

Industry 3451 includes establishments producing a wide variety of items such as small machinery parts, etc., on hand operated and automatic screw machines from rod, bar and tube stock and from castings and forgings. These products are produced almost entirely on a job or order basis. Included are screw machine departments or plants of companies primarily engaged in producing finished end products where such activities could be reported separately. However, in many instances captive screw machine operations were so integrated with other activities that separate reports were not obtained and the entire establishment was classified on the basis of its primary products.

3452 Bolts, Nuts, Screws, Rivets, and Washers (S-92; C-90).—Establishments primarily engaged in manufacturing bolts, nuts, screws, rivets, washers, formed and threaded wire goods, and special industrial fasteners. Rolling mills engaged in manufacturing similar products are classified in Major Group 33, and establishments primarily engaged in manufacturing screw machine products in industry 3451.

Plants included in industry 3452 in general are engaged in the manufacture of bolts, nuts, screws, and rivets of standard types and sizes on heading, threading, and nut forming machines. These establishments may be also engaged in the production of special industrial fasteners which require special or added operations or the use of special tools and fixtures. These items include bolts, nuts, screws, etc., of nonstandard types and sizes and special fasteners made by stamping and other forming processes. To a lesser extent these plants manufacture standard type bolts, nuts, screws, etc., on automatic and hand operated screw machines.

346 METAL STAMPINGS:

3461 Metal Stampings (S-84; C-86).—Establishments primarily engaged in manufacturing metal stampings by the use of tools, dies, jigs, and fixtues to punch, draw, form, or otherwise modify materials under pressure in a machine (primarily punch and draw presses).

Establishments in industry 3461 produce both job stampings and finished end products. Job stampings are made from materials owned by the stamping establishments as well as from materials owned by the customer and processed by the stamping establishments on a contract or commission basis. These stampings are mainly parts which are sold to manufacturers for incorporation into any of a wide variety of products such as refrigerators, agricultural machinery, radio and television sets. Finished end products manufactured by estblishments in this industry include cooking, kitchen, and hospital utensils (including domestic pressure cookers and porcelain enameled utenseils), pails, ash cans, garbage cans, perforated metal products, metal commercial and home canning closures as well as a large variety of miscellaneous items.

Industry 3461 includes the stamping departments of establishments primarily engaged in producing fabricated metal products where such stamping activites could be reported separately. However, where captive stamping operations were closely integrated with other activites, such as in the prodution of household appliances, farm equipment, motor vehicles, etc., separate reports were not obtained.

347 COATING, ENGRAVING, AND ALLIED SERVICES:

3471 Electroplating, Plating, Polishing, Anodizing, and Coloring (S[23]; C[24]).—Establishments primarily engaged in all types of electroplating, plating, anodizing, and coloring, and finishing of metals and formed products for the trade. Most of the work done in this industry is done on materials owned by others.

3479 Coating, Engraving, and Allied Services, N.E.C. (S[23]; C[24]).—Establishments primarily engaged in performing the following types of services on metals: (1) enameling, lacquering, and varnishing metal products for the trade; (2) hot dip galvanizing of mill sheets, plates and bars, castings, and formed products fabricated of iron and steel; in hot dip coating such items with aluminum, lead, or zinc; in retinning cans and utensils; (3) in engraving, chasing and etching jewelry, silverware, notarial and other seals, and other metal products for the trade and for job contracting for purposes other than printing; (4) and other metal services, n.e.c. Establishments primarily engaged in electroplating, plating, polishing, anodizing, coloring, and finishing of metals and formed products for the trade are classified in industry 3471; and those producing porcelain enameled products in industry 3461.

Industry 3479 includes establishments engaged primarily in enameling materials owned by others. Establishments primarily engaged in manufacturing vitreous-enameled products from their own materials are included in industry 3461. In addition, industry 3479 covers both vitreous and other types of enameling (such as baked enameling) whereas industry 3461 includes only vitreous-enameling establishments as well as those producing other types of metal stampings.

Industry 3479 includes establishments primarily engaged in galvanizing iron and steel sheets or formed products; in coating iron sheets or formed products with aluminum, lead, or zinc; and in retinning cans and utensils. Most of the work done in this industry is done on materials owned by others. Rolling mills engaged in galvanizing, tinning, and other coating are classified in industry 3312, and establishments primarily engaged in manufacturing galvanized steel wire, from purchased metal rods or bars, are classified in industry 3315.

Industry 3479 includes establishments primarily engaged in engraving, chasing, and etching jewelry, silverware, notarial seals, and other metal products for the trade, for purposes other than printing. Establishments primarily engaged in preparing metal lithographic plates and in printing from such media are classified in industry 2752; establishments primarily engaged in engraving and etching steel and copper plates and in using these plates to print stationary, visiting cards, etc., are included in industry 2753; and establishments primarily engaged in preparing photoengraved plates (halftones and linecuts) are classified in industry 2793.

348 MISCELLANEOUS FABRICATED WIRE PRODUCTS:

3481 Miscellaneous Fabricated Wire Products (S-93; C-65[25]).—Establishments primarily engaged in manufacturing miscellaneous fabricated wire products from purchased wire. Rolling mills engaged in manufacturing wire products are classified in Major Group 33; establishments manufacturing nonferrous wire nails and spikes in industry 3399; those drawing and insulating nonferrous wire in industry 3357; and those assembling wire bedsprings or seats are classified in Major Group 25.

349 MISCELLANEOUS FABRICATED METAL PRODUCTS:

3491 Metal Shipping Barrels, Drums, Kegs, and Pails (S-92; C-86).—Establishments primarily engaged in manufacturing ferrous and nonferrous shipping barrels, drums, kegs, and pails.

3492 Safes and Vaults (S-81; C-90-95).—Establishments primarily engaged in manufacturing fire or burglary resistive steel safes and vaults (except concrete grave vaults, industry 3272, and metal grave vaults, industry 3988), and similar fire or burglary resistive products.

3493 Steel Springs (S-91; C-67).—Establishments primarily engaged in manufacturing leaf springs, hot wound springs and coiled flat springs. Establishments primarily engaged in manufacturing wire springs are classified in industry 3481, and rolling mills manufacturing steel springs in industry 3312.

3494 Valves and Pipe Fittings, Except Plumbers' Brass Goods (S-86; C-85).—Establishments primarily engaged in manufacturing valves for controlling the flow of liquids or gases in pipes and mains, and for machinery. Establishments primarily engaged in manufacturing faucets, spigots, and similar plumbers' brass goods and fittings are classified in industry 3432.

3496 Collapsible Tubes (S-88; C-100).—Establishments primarily engaged in manufacturing collapsible tubes defined as cylindrical containers for viscous products, made of thin flexible metal, usually of tin, tin lined lead, lead, lead-tin alloy, or aluminum, with integral shoulder and neck, provided with an appropriate size opening in the throat, and usually with a screw cap made of plastic material for closure over the neck.

3497 Metal Foil and Leaf (S-84; C-45).—Establishments primarily engaged in manufacturing gold, silver, tin and other metal foil (including converted metal foil) and leaf. Establishments primarily engaged in manufacturing plain aluminum foil are classified in industry 3352.

3498 Fabricated Pipe and Fabricated Pipe Fittings (S-92; C-91).—Establishments primarily engaged in fabricating pipe and pipe fittings from purchased pipe, by cutting, threading, bending, etc. Establishments primarily engaged in manufacturing cast iron pipe and fittings, including cast and forged pipe fittings which have been machined and threaded, are classified in industry 3321; welded and heavy riveted pipe in industry 3317; and seamless steel pipe in industry 3317. Establishments primarily engaged in manufacturing products such as banisters, railings, and guards from pipe are classified in industry 3446.

3499 Fabricated Metal Products, N.E.C. (S-89; C-62).—Establishments primarily engaged in manufacturing fabricated metal products, n.e.c. Establishments primarily engaged in manufacturing advertising novelties are classified in industry 3993. Specific products of this industry include ammunition boxes, metal strapping, aluminum giftware (hammered), metal bookends, ladders, and fabricated railroad track equipment, such as switches, crossings, etc. Establishments primarily engaged in manufacturing castings or forgings are classified in Major Group 33; hardware in industry 3429; metal stampings in industry 3461; machine and equipment parts in Major Group 35 and Major Group 36.

35 MACHINERY, EXCEPT ELECTRICAL

This major group includes establishments engaged in manufacturing machinery and equipment, other than electrical equipment (Major Group 36) and transportation equipment (Major Group 37). Machines powered by built-in or detachable motors ordinarily are included in this major group, with the exception of electrical household appliances (Major Group 36). Portable tools, both electric and pneumatic powered, are included in this major group, but hand tools are classified in Major Group 34.

351 ENGINES AND TURBINES:

3511 Steam Engines; Steam, Gas, and Hydraulic Turbines; and Steam, Gas, and Hydraulic Turbine Generator Set Units (S-85; C-82).—Establishments primarily engaged in manufacturing steam engines; steam turbine; hydraulic turbines; gas turbines except aircraft; and complete steam, gas, and hydraulic turbine generator set units. Establishments primarily engaged in building or rebuilding locomotives are classified in industry 3741; and those manufacturing nonautomotive type generators which are not a part of a turbine generator set in industry 3621.

3519 Internal Combustion Engines, N.E.C. (S-86; C-86).—Establishments primarily engaged in manufacturing diesel, semi-diesel, or other internal combustion engines, n.e.c., for stationary, marine, traction, and other uses. Establishments primarily engaged in manufacturing aircraft engines, including rocket engines, are classified in industry 3722, automotive engines (except diesel) in SIC industry 3714 (Census industry 3717), and engine generator sets in industry 3621.

352 FARM MACHINERY AND EQUIPMENT:

3522 Farm Machinery and Equipment (S-89; C-95).—Establishments primarily engaged in manufacturing farm machinery, including equipment and wheel tractors, for use in the preparation and maintenance of the soil; planting and harvesting of the crop; preparing, on the farm, crops for market; or for use in performing other farm operations and processes. This industry includes wheel tractors, except contractors' off-highway type which are classified in industry 3531. Establishments primarily engaged in manufacturing industrial trucks, tractors, and trailers used for handling materials in industrial plants, depots, and docks are classified in industry 3537; and farm hand tools in industry Group 342.

353 CONSTRUCTION, MINING, AND MATERIALS HANDLING MACHINERY AND EQUIPMENT:

3531 Construction Machinery and Equipment (S-91; C-89).—Establishments primarily engaged in manufacturing heavy machinery and equipment used by the construction industries, such as bulldozers; concrete mixers; cranes, except industrial plant; dredging machinery; pavers, and power shovels. Establishments primarily engaged in manufacturing mining equipment are classified in industry 3532, and well drilling machinery in industry 3533.

3532 Mining Machinery and Equipment, Except Oil Field Machinery and Equipment (S-75; C-82).—Establishments primarily engaged in manufacturing heavy machinery and equipment used by the mining industries, such as coal breakers, mine cars, mineral cleaning machinery, concentration machinery, core drills, coal cutters, portable rock drills, and rock crushing machinery. Establishments primarily engaged in manufacturing construction machinery are classified in industry 3531, well drilling machinery in industry 3533, and coal and ore conveyors in industry 3535.

3533 Oil Field Machinery and Equipment (S-90; C-91).—Establishments primarily engaged in manufacturing machinery and equipment for use in oil and gas fields, or for drilling water wells.

3534 Elevators and Moving Stairways (S-97; C-95).—Establishments primarily engaged in manufacturing passenger or freight elevators, automobile lifts, dumb waiters, and moving stairways. Establishments primarily engaged in manufacturing commercial conveyor systems and equipment are classified in industry 3535, and farm elevators in industry 3522.

3535 Conveyors and Conveying Equipment (S-82; C-83).—Establishments primarily engaged in manufacturing conveyors and conveying equipment for installation in factories, warehouses, mines, and other industrial and commercial establishments. Establishments primarily engaged in manufacturing passenger or freight elevators, dumb waiters, and moving stairways are classified in industry 3534; and overhead traveling cranes and monorail systems in industry 3536.

3536 Hoists, Industrial Cranes, and Monorail Systems (S-80; C-70).—Establishments primarily engaged in manufacturing overhead traveling cranes, hoists, and monorail systems for installation in factories, warehouses, and other industrial and commercial establishments.

3537 Industrial Trucks, Tractors, Trailers, and Stackers (S-90; C-81).—Establishments primarily engaged in manufacturing industrial trucks, tractors, trailers, stackers (truck type), and related equipment, used for handling materials on floors and paved surfaces in and around industrial and commercial plants, depots, docks, and terminals. Establishments primarily engaged in manufacturing motor vehicles and motor vehicle type trailers are classified in Industry Group 371; farm type wheel tractors in industry 3522; wheel tractor shovel loaders, tracklaying tractors in industry 3531; and wood pallets and skids in industry 2499.

354 METALWORKING MACHINERY AND EQUIPMENT:

3541 Machine Tools, Metal Cutting Types (S-81; C-88).—Establishments primarily engaged in manufacturing power-driven machines, not supported in the hands of an operator when in use, that shape metal by cutting or use of electrical equipment; the rebuilding of such machine tools, and the manufacture of replacement parts for them. Metalworking, or primarily metalworking machine tools designed primarily for home workshops are also included. Establishments primarily engaged in the manufacture of electric welding equipment are classified in industry 3623; and portable power-driven hand tools, gas welding and cutting equipment, and automotive maintenance equipment in industry 3548.

3542 Machine Tools, Metal Forming Types (S-86; C-79).—Establishments primarily engaged in manufacturing power-driven machines, not supported in the hands of an operator while in use, for pressing, forging, hammering, extruding, shearing, banding or die casting metal into shape. This industry also includes rebuilding such machine tools and manufacturing repair parts for them. Establishments primarily engaged in the manufacture of electric welding equipment are classified in industry 3623; portable power-driven hand tools, gas welding and cutting equipment, and automotive maintenance equipment in industry 3548.

3544 Special Dies and Tools, Die Sets, Jigs, and Fixtures (S-93; C-72).—Establishments primarily engaged in manufacturing, on a job or order basis, special tools and fixtures for use with machine tools, hammers, die casting machines, and presses. The products of establishments classified in this industry include a wide variety of special toolings, such as dies; punches; die sets and components, and subpresses; jigs and fixtures; and special checking devices. Establishments primarily engaged in manufacturing metal molds for casting metals, for rubber working, plastic working glass working and similar machinery are also included.

This industry comprises establishments commonly known as contract tool and die shops; also included are captive tool and die shops of metal-products producers, where such shops were separately operated and separate reports were filed. However, the total value of shipments excludes the captive production of tool and die departments making these products for the exclusive use of the producing establishment.

3545 Machine Tool Accessories and Measuring Devices (S-83; C-84).—Establishments primarily engaged in manufacturing cutting tools, machinists' precision measuring tools, and attachments and accessories for machine tools and for other metalworking machinery, n.e.c. Establishments primarily engaged in manufacturing hand tools, except power-driven, are classified in Industry Group 342.

3548 Metalworking Machinery, Except Machine Tools and Power-Driven Hand Tools (S-85; C-88).—Establishments primarily engaged in manufacturing metalworking machinery such as rolling mill machinery and equipment, power-driven hand tools, welding equipment, wire fabricating machinery and equipment, except wire drawing dies, and automotive maintenance machinery and equipment. Establishments primarily engaged in manufacturing machine tools, metal cutting types, are classified in industry 3541, and those primarily engaged in manufacturing machine tools, metal forming types, in industry 3542.

355 SPECIAL INDUSTRY MACHINERY, EXCEPT METAL WORKING MACHINERY:

These industries include establishments primarily engaged in producing industrial machinery, except metalworking machinery, specially designed for use in a specific industry or in a group of industries. Machinery having general industrial application, i.e., used in a number of industries, rather than in specific applications are not included in this group but are included in industry Group 356. Examples of general industrial machinery are pumps and compressors, fans and blowers, and mechanical power transmission equipment.

3551 Food Products Machinery (S-86; C-87).—Establishments primarily engaged in manufacturing machinery for use by the food products and beverage manufacturing industries in the preparation, canning, or packaging of food products and parts and attachments. Establishments primarily engaged in manufacturing refrigeration machinery are classified in industry 3585; household electrical appliances such as mixers, cookers, etc., are classified in industry 3634.

3552 Textile Machinery (S-93; C-94).—Establishments primarily engaged in manufacturing machinery for the textile industries, and extra parts, attachments, and accessories. Establishments primarily engaged in manufacturing domestic or industrial sewing machines are classified in industry 3636.

3553 Woodworking Machinery (S-80; C-83).—Establishments primarily engaged in manufacturing machinery for sawmills, planing mills, cabinet and furniture makers, pattern makers, and veneer workers.

Establishments primarily engaged in manufacturing hand tools such as planes, axes, drawknives, and hand saws are classified in Industry Group 342, and portable power-driven hand tools in industry 3548.

3554 Paper Industries Machinery (S-88; C-90).—Establishments primarily engaged in manufacturing machinery for the paper-pulp, paper, and paper product industries. Establishments primarily engaged in rebuilding pulp and paper industries machinery are also included in this industry. Establishments primarily engaged in manufacturing printing trades machinery are classified in industry 3555.

3555 Printing Trades Machinery and Equipment (S-95; C-93).—Establishments primarily engaged in manufacturing machinery and equipment used by the printing and bookbinding trades. Important products of this industry include bookbinding and photoengraving machinery; printers' machinery such as presses, typesetting, typefounding, electrotyping, and stereotyping machines; engravers' equipment (metal plates, wood blocks, and lithographic stones); printers' rollers, rules, sticks, blocks, and type cases; and type, leads, and slugs. Establishments primarily engaged in manufacturing textile printing machinery are classified in industry 3552.

359 Special Industry Machinery, N.E.C. (S-83; C-73).—Establishments primarily engaged in manufacturing special industry machinery, n.e.c., such as smelting and refining equipment, cement making, clay working, glass making, hat making, incandescent lamp making, leather working, paint making, rubber working, tobacco working, cigar and cigarette making, shoe making, and stone working machinery.

356 GENERAL INDUSTRIAL MACHINERY AND EQUIPMENT:

3561 Pumps, Air and Gas Compressors, and Pumping Equipment (S-85; C-86).—Establishments primarily engaged in manufacturing pumps, compressors, and pumping equipment for general industrial use. Establishments primarily engaged in manufacturing measuring and dispensing pumps for gasoline service station use are classified in industry 3586; and ice making, refrigerating, and air conditioning units in industry 3585.

3562 Ball and Roller Bearings (S-97; C-98).—Establishments primarily engaged in manufacturing ball and roller bearings and parts. Establishments primarily engaged in manufacturing bearings, except ball and roller, are classified in Industry 3566.

3564 Blowers and Exhaust Ventilation Fans (S-83; C-79).—Establishments primarily engaged in manufacturing blowers, and exhaust and ventilating fans for general industrial, commercial, and household use. Establishments primarily engaged in manufacturing complete air conditioning units are classified in Industry 3585, and free air circulating fans for use on desks, pedestals, or wall brackets in Industry 3634.

3565 Industrial Patterns (S-96; C-80).—Establishments primarily engaged in manufacturing industrial patterns.

3566 Mechanical Power Transmission Equipment, Except Ball and Roller Bearings (S-84; C-79).—Establishments primarily engaged in manufacturing mechanical power transmission equipment for industrial machinery. Establishments primarily engaged in manufacturing automotive, tank, and tractor power transmission equipment are classified in SIC industry 3714 (Census industry 3717); aircraft power transmission equipment in industry 3729; and ball and roller bearings in industry 3562.

3567 Industrial Process Furnaces and Ovens (S-82; C-86).—Establishments primarily engaged in manufacturing industrial process furnaces, ovens, induction and dieelectric heating equipment, and related devices.

3569 General Industrial Machinery and Equipment, N.E.C. (S-83; C-70).—Establishments primarily engaged in manufacturing machinery, equipment, and components for general industrial use, and for which no special classification is provided. Machine shops primarily engaged in producing machine and equipment parts, usually on a job or order basis, are classified in Industry 3599.

Industry 3569 covers a wide range of products such as filters and strainers for internal combustion engines (except automobile engines), hydraulic jacks, packaging and wrapping machines (except food and tobacco), centrifugals and separators (except cream), gas generating equipment, brake burnishing and washing machines, ice crusher machinery, fire hose (except rubber), fire hose dryers and racks, automatic sprinkler systems, general industrial labeling machines, and magnetic separation equipment.

357 OFFICE, COMPUTING, AND ACCOUNTING MACHINES:

3571 Computing and Accounting Machines, Including Cash Registers (S-93; C-94).—Establishments primarily engaged in manufacturing computing machines including electronic, accounting machines, and cash registers. Establishments primarily engaged in manufacturing typewriters are classified in industry 3572, and office duplicating machines and devices and autographic registers in industry 3579.

3572 Typewriters (S-85; C-99).—Establishments primarily engaged in manufacturing typewriters and parts.

3576 Scales and Balances, Except Laboratory (S-92; C-97).—Establishments primarily engaged in manufacturing weighing and force measuring machines and devices of all types, except those regarded as scientific apparatus for laboratory and experimental work which are classified in industry 3811.

3579 Office Machines, N.E.C. (S-81; C-79).—Establishments primarily engaged in manufacturing office machines and devices, n.e.c. Establishments primarily engaged in manufacturing computing machines and cash registers are classified in industry 3571, typewriters in industry 3572, and photocopy and microfilm equipment in industry 3861.

358 SERVICE INDUSTRY MACHINES:

3581 Automatic Merchandising Machines (S-81; C-90).—Establishments primarily engaged in manufacturing automatic merchandising units, also referred to as vending machines (excluding music, amusement, or gaming machines) and coin-operated mechanisms for such machines. Coin-operated amusement and gaming machines are classified in industry 3999 and coin-operated phonographs in industry 3651.

3582 Commercial Laundry, Dry Cleaning, and Pressing Machines (S-91; C-89).—Establishments primarily engaged in manufacturing laundry and dry-cleaning equipment and pressing machines for commercial and industrial use. Establishments primarily engaged in manufacturing household laundry equipment are classified in industry 3633. Although the SIC classifies coin-operated household washing machines in industry 3582, data for these machines are included in the 1963 Census of Manufactures, as in 1958, in industry 3633.

3585 Air Conditioning Equipment and Commercial and Industrial Refrigeration Machinery and Equipment (S [illegible]; C [illegible]).—Establishments primarily engaged in manufacturing equipment and systems utilizing the basic refrigeration cycle, including mechanical and absorption refrigerators for commercial and industrial use; refrigeration machinery, and complete air conditioning units for domestic, commercial, and industrial use. Establishments primarily engaged in manufacturing soda fountain and beer-dispensing equipment are classified in this industry, and those primarily engaged in manufacturing household refrigerators and home and farm freezers in Industry 3632.

3586 Measuring and Dispensing Pumps (S-73; C-85).—Establishments primarily engaged in manufacturing measuring and dispensing pumps commonly used in service and filling stations for dispensing gasoline, oil, and grease, including grease guns. Establishments primarily engaged in manufacturing pumps, compressors and pumping equipment for general use are classified in industry 3561.

3589 Service Industry Machines, N.E.C. (S-86; C-84).—Establishments primarily engaged in manufacturing machines and equipment, not elsewhere classified, for use in service industries, such as floor sanding machines, industrial vacuum cleaners, scrubbing machines, commercial cooking and food warming equipment, and commercial dishwashing machines. Establishments primarily engaged in manufacturing household electric appliances are classified in Industry Group 363.

359 MISCELLANEOUS MACHINERY, EXCEPT ELECTRICAL:

3599 Miscellaneous Machinery, Except Electrical (S-90; C-90).—Establishments primarily engaged in manufacturing machinery and parts except electrical, not elsewhere classified, such as piston and piston rings, carburetors, metallic packing, and amusement park equipment. This industry also includes establishments primarily engaged in producing or repairing machine and equipment parts, n.e.c., on a job or order basis for others. These establishments usually operate on a job, or order basis and are equipped with machine tools and other power-driven metalworking machinery capable of manufacturing a wide range of machine and equipment parts. Machine shops classified in this industry are characterized by their method of operation rather than their product, and the fact that they may be primarily engaged in repair work does not exclude them from this classification; however, machine shops engaged exclusively in repair work are classified in repair industries.

Although generally characterized by method of operation rather than type of product, establishments primarily engaged in manufacturing the following products are classified in Industry 3599: metal bellows, bushings machined from purchased castings, carburetors, catapults, boiler-tube cleaners, valve cores, hydraulic cylinders, iron flasks, flexible metal hose and tubing, metallic packing (except asbestos-metallic), pistons and piston rings, and intake and exhaust valves for internal combustion engines.

36 ELECTRICAL MACHINERY, EQUIPMENT, AND SUPPLIES

This major group includes establishments engaged in manufacturing machinery, apparatus, and supplies for the generation, storage, transmission, transformation, and utilization of electrical energy. The manufacture of household appliances is included in this group, but industrial machinery and equipment powered by built-in or detachable electric motors is classified in Major Group 35.

361 ELECTRIC TRANSMISSION AND DISTRIBUTION EQUIPMENT:

3611 Electrical Measuring Instruments and Test Equipment (S-84; C-78).—Establishments primarily engaged in manufacturing pocket, portable, panelboard and graphic recording instruments for measuring electricity, such as voltmeters, ammeters, wattmeters, watthour meters, demand meters and other meters and indicating instruments. This industry also includes establishments primarily engaged in manufacturing analyzers for testing the electrical characteristics of internal combustion engines, radio apparatus, etc.

3612 Power, Distribution and Specialty Transformers (S-92; C-94).—Establishments primarily engaged in manufacturing power, distribution and specialty transformers. Establishments primarily engaged in manufacturing radio frequency or voice frequency transformers, coils or chokes are classified in industry 3679, and resistor welding transformers in Industry 3623.

3613 Switchgear and Switchboard Apparatus (S-87; C-89).—Establishments primarily engaged in manufacturing switchgear and switchboard apparatus. Important products of this industry include power switches, circuit breakers, power switching equipment, and similar switchgear for general industrial application; switchboards and cubicles, control and metering panels, power fuse mountings, and similar switchboard apparatus and

supplies. Establishments primarily engaged in manufacturing industrial controls are classified in industry 3622, and those manufacturing current carrying wiring devices in industry 3643.

362 ELECTRICAL INDUSTRIAL APPARATUS:

3621 Motors and Generators (S-81; C-84).—Establishments primarily engaged in manufacturing electric motors (except starting motors) and power generators; motor generator sets; railway motors and control equipment; and motors generators and control equipment for gasoline electric and oil electric busses and trucks. Establishments primarily engaged in manufacturing turbogenerators are classified in industry 3511 and starting motors and battery charging generators for internal combustion engines in industry 3694.

3622 Industrial Controls (S-79; C-79).—Establishments primarily engaged in manufacturing motor starters and controllers, control accessories, electronic controls, and other industrial controls. Establishments primarily engaged in manufacturing automatic temperature controls are classified in industry 3822.

3623 Welding Apparatus (S-93; C-89).—Establishments primarily engaged in the manufacture of welding apparatus and accessories. Important products of this industry include arc welding machines, spot, projection, seam, flash and other resistance welders, welding electrodes, electrode holders and other welding machine accessories. Establishments primarily engaged in coating welding wire from purchased wire or wire drawn in the same establishment are also included. Establishments primarily engaged in manufacturing gas welding apparatus are classified in industry 3548.

3624 Carbon and Graphite Products (S-93; C-96).—Establishments primarily engaged in the manufacture of carbon and graphite products for use in the electrical industries. This industry comprises establishments primarily engaged in manufacturing lighting carbons; carbon, graphite, and metal-graphite brushes and brush stock; carbon or graphite electrodes for thermal and electrolytic uses; and other carbon, graphite, and metal-graphite products for use in the electrical industries.

3629 Electrical Industrial Apparatus, N.E.C. (S-80; C-72).—Establishments primarily engaged in manufacturing industrial and commercial electric apparatus and equipment, n.e.c., such as blasting machines, and fixed and variable capacitors, condensers and rectifiers for industrial application.

Establishments primarily engaged in manufacturing fixed and variable capacitors and condensers for electronic end products are classified in industry 3679, and rectifiers for electronic end products in industry 3674.

363 HOUSEHOLD APPLIANCES:

3631 Household Cooking Equipment (S-87; C-72).—Establishments primarily engaged in manufacturing household cooking equipment, such as stoves, ranges, and ovens. Establishments primarily engaged in manufacturing household cooking appliances, such as hot plates, grills, percolators, and toasters are classified in industry 3634. Establishments primarily engaged in manufacturing commercial cooking equipment are classified in industry 3589.

3632 Household Refrigerators and Home and Farm Freezers (S-66; C-99).—Establishments primarily engaged in manufacturing household refrigerators and home and farm freezers. Establishments primarily engaged in manufacturing commercial and industrial refrigeration equipment, packaged room coolers, and dehumidifiers are classified in industry 3585.

3633 Household Laundry Equipment (S-89; C-87).—Establishments primarily engaged in manufacturing laundry equipment such as washing machines, wringers, dryers, and ironers for household use. Establishments primarily engaged in manufacturing commercial laundry equipment are classified in industry 3582.

3634 Electric Housewares and Fans (S-87; C-81).—Establishments primarily engaged in manufacturing electric housewares for heating, cooking, and other purposes; and electric fans. Important products of this industry include electric air heaters, bed coverings, blenders, broilers, deep fat fryers, flat irons, food mixers, hot plates, percolators and coffee makers, roasters, toasters, desk and bracket fans, and hassock or floor fans.

3635 Household Vacuum Cleaners (S-87; C-80).—Establishments primarily engaged in manufacturing vacuum cleaners for household use. Establishments primarily engaged in manufacturing vacuum cleaners for industrial use are classified in industry 3589.

3636 Sewing Machines (S-90-95; C-96).—Establishments primarily engaged in manufacturing sewing machines for domestic and industrial use.

3639 Household Appliances, N.E.C. (S-79; C-79).—Establishments primarily engaged in manufacturing household appliances, n.e.c., such as hot water heaters, dishwashers, and food waste disposal units.

364 ELECTRIC LIGHTING AND WIRING EQUIPMENT:

3641 Electric Lamps (S-95; C-96).—Establishments primarily engaged in manufacturing electric bulbs, tubes and related light sources. Important products of this industry include incandescent filament lamps, vapor and fluorescent lamps, photoflash and photoflood lamps, electrotherapeutic lamps, units for ultra violet and infrared radiation and other electric light sources. Establishments primarily engaged in manufacturing glass blanks for bulbs are classified in industry 3229; and lamp components, such as filaments, supports, lead-in wires and cold cathode fluorescent lamp electrodes in industry 3699.

3642 Lighting Fixtures (S-93; C-93).—Establishments primarily engaged in manufacturing lighting fixtures and equipment of any type, including electric and gas lighting fixtures; carbide, kerosene and gasoline lamps; and metal reflectors and fittings. Establishments primarily engaged in producing glassware for lighting fixtures are classified in Major Group 32; electric light bulbs, tubes and related light sources in industry 3641.

3643 Current Carrying Wiring Devices (S-80; C-83).—Establishments primarily engaged in manufacturing current carrying wiring devices. Important products of this industry include attachment plugs and caps, convenience outlets, lamp sockets and receptacles, snap switches, conductor connectors, overhead trolley line material, rail bonds for both propulsion and signal circuits, lightning arrestors, and other lightning protective equipment.

3644 Noncurrent Carrying Wiring Devices (S-77; C-80).—Establishments primarily engaged in manufacturing noncurrent carrying wiring devices. Important products of this industry include conduits and fittings, electrical insulators and insulation materials, except porcelain insulators (industry 3264) and glass insulators (industry 3229); outlet switch and fuse boxes; and pole-line hardware.

365 RADIO AND TELEVISION RECEIVING SETS, EXCEPT COMMUNICATION TYPES:

3651 Radio and Television Receiving Sets, Except Communication Types (S-91; C-96).—Establishments primarily engaged in manufacturing equipment for home entertainment. This industry also includes establishments primarily engaged in manufacturing public address systems, and music distribution apparatus, except records. Establishments primarily engaged in manufacturing records are classified in industry 3652; radio and television receiving type tubes in industry 3671; and television receiving type cathode ray tubes in industry 3672.

3652 Phonograph Records (S-99; C-97).—Establishments primarily engaged in manufacturing phonograph records and pre-recorded magnetic tapes. Establishments primarily engaged in manufacturing electronic equipment for home entertainment, except records, are classified in industry 3651.

366 COMMUNICATION EQUIPMENT:

3661 Telephone and Telegraph Apparatus (S-95; C-95).—Establishments primarily engaged in manufacturing wire telphone and telegraph equipment and parts especially designed for telephone and telegraph use.

3662 Radio and Television Transmitting, Signaling, and Detection Equipment and Apparatus (S-88; C-91).—Establishments primarily engaged in manufacturing (1) radio and television broadcasting equipment; (2) electric communication equipment and parts, except telephone and telegraph; (3) electronic field detection apparatus, light and heat emission operation apparatus, object detection apparatus and navigational electronic equipment, and aircraft and missile control systems; and (4) other electric and electronic communication and signaling products, n.e.c. Establishments primarily engaged in manufacturing transmitting tubes are classified in industry 3673.

367 ELECTRONIC COMPONENTS AND ACCESSORIES:

3671 Radio and Television Receiving Type Electron Tubes, Except Cathode Ray (S-89; C-95).—Establishments primarily engaged in manufacturing radio and television receiving type electron tubes, except cathode ray tubes. Establishments primarily engaged in manufacturing television receiving type cathode ray tubes are classified in industry 3672; transmitting tubes in industry 3673; X-ray tubes in industry 3693; and electronic equipment for home entertainment, except tubes, in industy 3651.

3672 Cathode Ray Picture Tubes (S-85-90; C-90).—Establishments primarily engaged in manufacturing television receiving type cathode ray tubes. Establishments primarily engaged in manufacturing other radio and television receiving type electron tubes are classified in industry 3671; and transmitting tubes in industry 3673.

3673 Transmitting, Industriol and Speciol Purpose Elactron Tubes (S-80; C-75).—Estoblishments primoriiy engoged in manufacturing transmitting, industriol, and special purpose elactron tubes. Estoblishments primoriiy engoged in manufacturing radio and televisian transmitting equipment are classified in industry 3662; rodio and televisian receiving tubes in industry 3671; televisian receiving type cathode ray tubes in industry 3672; and X-ray tubes in industry 3693.

3674 Semiconductor (Soiid State) and Reioted Devices (S-88; C-92).—Estabiishments primariiy engoged in manufacturing semicanductor (solid state) and reiated devices, such as semicanductar diodes and stocks, including rectifiers; transistors; saior cells; ond light sensitive semiconductor (sotid state) devices.

This industry was not included in the Standord Industriol Classification in 1958. In the iatter year it was part of industry 3679.

3679 Electronic Components and Accessories, N.E.C. (S-89; C-78).—Estabiishments primariiy engaged in manufacturing speciaity resistors for electranic end products; inductars; eletranic transformers and capacitors; and other electronic components, n.e.c. Estoblishments primoriiy engaged in manufacturing resistors, inductors, and transformers far telephane and telegroph apparatus ore classified in industry 3661; electric iamps in industry 3641; and samiconductar (soiid state) and reiated devices in industry 3674.

This industry in 1963 differs from the classification in 1958. industry 3674, o separate industry in 1963, was formeriy port of 3679.

369 MISCELLANEOUS ELECTRICAL MACHINERY EQUIPMENT AND SUPPLIES:

3691 Storage Batteries (S-98; C-99).—Establishments primoriiy engoged in the manufacture of storage batteries far outomobiies, trucks, farm tractars and busses as weii as staroge botteries far form uses, communications systems and railrood equipment. Parts far staroge batteries ore aisa included in this industry.

3692 Primory Botteries, Dry ond Wet (S-96; C-91).—Estabiishments primarily engoged in the manufacture af dry and wet ceii primory botteries for floshlights, railroad ianterns hearing aids, portable radios, farm radias, and generoi purposes os weii os parts and supplies for primory botteries.

3693 Rodiographic X-ray, Fiuaroscopic X-ray and Other X-ray Apparaius and Tubes (S-83; C-80).—Estabiishments primariiy engoged in manufacturing radiographic X-ray, fluorascapic X-roy, ond therapeutic X-roy opparotus and tubes for medicai, industriat, research ond controi appiicotions. Establishments primarily engaged in manufacturing radio receiving type tubes are classified in industry 3671; television receiving cathode ray tubes in industry 3672; transmitting tubes in industry 3673, and electratheropeutic iamp units for ultro-violet and infro-red radiation in industry 3641.

3694 Electricai Equipment for Internoi Cambustion Engines (S-93; C-81).—Estoblishments primoriiy engoged in manufacturing electrical equipmant for internoi combustian engines. important praducts of this industry include starting motors and generators for automobiles and aircraft; and ignitian apparatus for internal combustion engines, including spark piugs, magnetas, coils, and distributors.

3699 Electricai Machinery, Equipment, and Supplies N.E.C. (S-90, C-49 [26]).—Estobiishments primarily engaged in manufacturing electrical machinery, equipment and suppiias, n.e.c.

37 TRANSPORTATION EQUIPMENT

This major group includes estabiishments engaged in manufacturing equipment transpartatian of passengers and cargo by land, air, and water. apartant products produced by estabiishments classified in this major graup include motor vehicles, aircraft, ships, boats, railroad equipment, and miscellaneous transpartatian equipment such as motorcycles, bicycles, and horse drawn vehicles.

371 MOTOR VEHICLES AND MOTOR VEHICLE EQUIPMENT:

3713 Truck and Bus Bodies (S-88; C-86).—Estabiishments primarily engaged in the manufacture af truck and bus bodies, for sale separately or for assembiy an purchased chassis. Estobiishments primariiy engaged in manufacturing complete trucks and busses are classified in industry 3717, and stamped body parts for trucks and busses in industry 3461.

3715 Truck Trailers (S-92; C-93).—Estobiishments primarily engaged in the manufacture of truck trailers and truck trailar chassis for sale separateiy, but not engaged in manufacturing complete trucks and busses. Estoblishments primarily engaged in manufacturing trailer bodies ore classified in industry 3713. Those primariiy engaged in manufacturing passengar car trailers are classified in industry 3799; and those primariiy engaged in manufacturing trailer coaches are classified in industry 3791.

3717 Motor Vehicles and Parts (S-97; C-98)[1].—Establishments primarily engaged in manufacturing or assembiy af complete passenger automobiies, car bodies, trucks, commercioi cars and busses (except trackless trolieys industry 3742), speciol purpase motor vehicias such as ambuiances, fire engines, toxicabs, scout cars, persannel carriers, amphibian motor vehicies, and selected parts and accessories for motor vehicles. Estabiishments primariiy engaged in manufacturing motar vehicies on purchased chassis (ambuiances, fire engines, etc.) are classified in industry 3713.

In the 1963 Census of Manufacturers, as in 1958, the three SIC industries (3711, 3712, and 3714) have been combined because of a major problem of defining the reporting unit in terms af these industries. This difficulty arises from the fact that many iarge estoblishments hove integroted operations which include the productian of parts ar bodies and the assembiy af complete vehicles at the some location.

Included in industry 3717 ore such parts as passenger-car badies, matar vehicle engines (except diesel), brakes, clutches, axies, radiators, differentials, transmissions, wheels and frames, windshield wipers, automotive bumpers, camshafts, connecting rods, crankshaft assemblies, cylinder heads, drive shafts, exhaust systems, fuel systems, heaters, hoods, horns, instrument board assemblies, lubrication systems, mufflers, power-transmission equipment, rear-axle housings, shock absarbers, steering mechanisms, universoi joints, wheei rims, windshield frames, and outamobile accessories, n.e.c.

A considerable number of components, parts, and accessaries for motor vehicles ore not classified in industry 3717 but are classified in other Standard industriai Classificatian industrias bosed an the charocteristic of the product itsalf rather than the use to which it is put. Among the more important of these are automotive hardware, industry 3429; autamotive stampings, industry 3461; diesel and samidiesel engines, industry 3519; sealed beam and other electric lamps, industry 3641; motar vehicle lighting fixtures, industry 3642; tira and inner tubes, industry 3011; automobile glass, industry 3211; ignition equipment such as spark piugs, distributors, switches, ignition coils, generators, cranking mators etc., industry 3694; storage batteries, industry 3691; automabile radias, industry 3651; and carburetars and pistons, industry 3599.

372 AIRCRAFT AND PARTS:

3721 Aircraft (S-69; C-96).—Establishments primoriiy engaged in manufacturing ar assembiing complete aircraft. This industry includes estoblishments primariiy engaged in factory type aircraft modification on a contract or fee basis. Estoblishments primariiy engoged in manufacturing engines, propellers, and other aircraft parts and auxiiiary equipment are classified in industries 3722, 3723, and 3729.

3722 Aircraft Engines, and Engine Parts (S-87; C-93).—Estabiishments primarily engaged in manufacturing aircraft engines, complete missile ar space vehicle engines and/or propulsion units ond their parts.

3723 Aircraft Propellers and Propeller Parts (S-48; C-81).—Estoblishments primariiy engaged in manufacturing aircraft propellers and propeiier ports.

3729 Aircaft Ports and Auxiiiary Equipment, N.E.C. (S-75; C-59).—Estabiishments primariiy engoged in manufacturing aircraft parts and auxiiiary equipment, n.a.c. Establishments primarily engaged in manufacturing ar assembling complete aircraft are classified in industry 3721, aircraft engines and parts in industry 3722, propellers and propeiiar parts in industry 3723, aeronautical instruments in industry 3811, and aeronautical electricoi equipment in industry 3694.

373 SHIP AND BOAT BUILDING AND REPAIRING:

3731 Ship Building and Repairing (S-92; C-99).—Estoblishments primarily engaged in building and repairing ali types of ships, bargas, canal boats and lighters, whether propelled by soil or motar power or towed by athar craft. This industry alsa included the canversian and raconversion of ships. Establishments primarily engaged in fabricating structural assemblies or campanents for ships or subcontractors engaged in ship painting, joinery, carpentry wark, electricai wiring installations atc., are not classified in this industry.

3732 Boat Building and Repairing (S-97; C-95).—Estabiishments primariiy engaged in building and repairing of boats, except rubber boats (industry 3069). Estobiishments primoriiy engaged in cleaning and staring boats and the rental of dock spaca, and yacht ciubs ore classified in nanmanufacturing industries.

374 RAILROAD EQUIPMENT:

3741 Locomotives and Parts (S-83; C-90)[1].—Estoblishments primariiy engaged in buiiding and rebuiiding locamatives (including frames

and parts, n.e.c.) of any type or gauge. Railroad shops rebuilding and repairing locomotives, or building new locomotives, are classified in Major Group 40.

3742 Railroad and Street Cars (S-91; C-93).—Establishments primarily engaged in building and rebuilding railroad, street, and rapid transit cars and car equipment for operation on rails for freight and passenger service. This industry also includes establishments primarily engaged in manufacturing trackless trolley busses. Establishments primarily engaged in manufacturing mining cars are classified in industry 3532. Repair shops owned and operated by railroad or local transit companies, rebuilding or repairing cars, or building new cars for their own account, are classified in Major Groups 40 and 41.

375 MOTORCYCLES, BICYCLES, AND PARTS:

3751 Motorcycles, Bicycles, and Parts (S-83; C-93).—Establishments primarily engaged in manufacturing motorcycles, bicycles, and similar equipment and parts. Establishments primarily engaged in assembling motorcycles or bicycles from purchased parts are also included in this industry. Establishments primarily engaged in manufacturing children's vehicles, except bicyles, are classified in industry 3943.

379 MISCELLANEOUS TRANSPORTATION EQUIPMENT:

3791 Trailer Coaches (S-98; C-99).—Establishments primarily engaged in manufacturing trailer coaches (mobile dwellings) for attachment to passenger cars and pickup coaches (campers) for mounting on pick-up trucks.

3799 Transportation Equipment, N.E.C. (S-89; C-75).—Establishments primarily engaged in manufacturing transportation equipment, n.e.c. Establishments primarily engaged in manufacturing industrial trucks, tractors, trailers, and stackers are classified in industry 3537, and children's vehicles, except bicycles, in industry 3943.

38 PROFESSIONAL SCIENTIFIC, AND CONTROLLING INSTRUMENTS; PHOTOGRAPHIC AND OPTICAL GOODS; WATCHES AND CLOCKS

This major group includes establishments engaged in manufacturing mechanical measuring, engineering, laboratory, and scientific research instruments; optical instruments and lenses; surgical, medical, and dental instruments, equipment, and supplies; ophthalmic goods; photographic equipment and supplies; and watches and clocks. Establishments primarily engaged in manufacturing instruments for indicating, measuring, and recording electrical quantities and characteristics are classified in industry 3611.

381 ENGINEERING, LABORATORY, AND SCIENTIFIC AND RESEARCH INSTRUMENTS AND ASSOCIATED EQUIPMENT:

3811 Engineering, Laboratory, and Scientific and Research Instruments and Associated Equipment. (S-84; C-56).—Establishments primarily engaged in manufacturing laboratory, scientific, and engineering instruments such as nautical, navigational, aeronautical, surveying, drafting, and instruments for laboratory work and scientific research (except optical instruments, industry 3831). Establishments primarily engaged in manufacturing surgical and medical instruments are classified in industry 3841; dental instruments and equipment in industry 3843; mechanical measuring and controlling instruments in industry 3821; machinists' precision measuring tools in industry 3545; instruments for indicating, measuring, and recording electrical quantities and characteristics in industry 3611; watches and clocks in industry 3871; measuring and dispensing pumps in industry 3586.

382 INSTRUMENTS FOR MEASURING, CONTROLLING, AND INDICATING PHYSICAL CHARACTERISTICS:

3821 Mechanical Measuring and Controlling Instruments, Except Automatic Temperature Controls (S-90; C-83).—Establishments primarily engaged in manufacturing industrial process instruments for indicating, recording, measuring and controlling temperature (except automatic temperature controls, industry 3822), pressure and vacuum, fluid flow and liquid level, mechanical motion, rotation, humidity, density, acidity, alkalinity and combustion; dial pressure gauges; physical property testing apparatus such as hardness, tension, compression, torsion, ductility, elasticity testing apparatus.

3822 Automatic Temperature Controls (S-82; C-95).—Establishments primarily engaged in manufacturing automatic temperature controls activated by pressure, temperature, level, flow, time, or humidity (including pneumatic controls) of the type principally used as components of household apparatus. Establishments primarily engaged in manufacturing industrial electric controls are classified in industry 3622.

383 OPTICAL INSTRUMENTS AND LENSES:

3831 Optical Instruments and Lenses (S-90; C-61).—Establishments primarily engaged in the production of optical lenses and prisms, and in manufacturing optical instruments such as microscopes, telescopes, field and opera glasses; and optical measuring and testing instruments such as refractometers, spectrometers, spectroscopes, colorimeters, polariscopes. Establishments primarily engaged in manufacturing eyeglass lenses, frames, or fittings are classified in industry 3851; and those engaged in manufacturing sighting and fire control instruments, but not engaged in manufacturing optical components, in industry 1941.

384 SURGICAL, MEDICAL, AND DENTAL INSTRUMENTS AND SUPPLIES:

3841 Surgical and Medical Instruments and Apparatus (S-88; C-74).—Establishments primarily engaged in manufacturing medical, surgical, ophthalmic, and veterinary instruments and apparatus. Establishments primarily engaged in manufacturing surgical and orthopedic appliances are classified in industry 3842; and electrotherapeutic, electromedical, and X-ray apparatus in industry 3693.

3842 Orthopedic, Prosthetic and Surgical Appliances and Supplies (S-80; C-90).—Establishments primarily engaged in manufacturing orthopedic, prosthetic, and surgical appliances and supplies, arch supports, and other foot appliances; fracture appliances, elastic hosiery, abdominal supporters, braces, and trusses; bandages; surgical gauze and dressings; sutures; adhesive tapes and medicated plasters; and personal safety appliances and equipment. Establishments primarily engaged in manufacturing surgical and medical instruments are classified in industry 3841. Establishments primarily engaged in manufacturing appliances and in the personal fitting to the individual prescription of a physician are classified in trade industries.

3843 Dental Equipment and Supplies (S-94; C-92).—Establishments primarily engaged in manufacturing artificial teeth, dental metals, alloys and amalgams, and a wide variety of equipment, instruments and supplies used by dentists, dental laboratories, and dental colleges. Dental laboratories constructing artificial dentures, bridges, inlays and other dental restorations on specifications from dentists are classified in service industries.

385 OPHTHALMIC GOODS:

3851 Ophthalmic Goods (S-86; C-92).—Establishments primarily engaged in manufacturing ophthalmic frames, lenses, and sunglass lenses. Establishments primarily engaged in manufacturing slit lamps are classified in industry 3841, and molded glass blanks in industry 3229. Establishments primarily engaged in grinding lenses and fitting glasses to prescription are classified in trade industries.

386 PHOTOGRAPHIC EQUIPMENT AND SUPPLIES:

3861 Photographic Equipment and Supplies (S-95; C-97).—Establishments primarily engaged in manufacturing (1) photographic apparatus, equipment, parts, attachments, and accessories, such as still and motion picture cameras and projection apparatus; photocopy and microfilm equipment; blueprinting and diazotype (white printing) apparatus and equipment; and other photographic equipment; and (2) sensitized film, paper, cloth, and plates, and prepared photographic chemicals for use therewith. Establishments primarily engaged in manufacturing photographic paper stock (unsensitized); and paper mats, mounts, easels and folders for photographic use are classified in Major Group 26; photographic lenses in industry 3831; photographic glass in Major Group 32; chemicals for technical purposes, not specifically prepared and packaged for use in photography, in Major Group 28; and photographic flash, flood, enlarger and projection lamps in industry 3641.

387 WATCHES, CLOCKS, CLOCKWORK OPERATED DEVICES, AND PARTS:

3871 Watches, Clocks, and Parts Except Watchcases (S-82; C-95).—Establishments primarily engaged in manufacturing clocks (including electric), watches, mechanisms for clockwork operated devices, and clock and watch parts. This industry includes establishments primarily engaged in assembling clocks and watches from purchased movements and cases. Establishments primarily engaged in manufacturing watchcases are classified in industry 3872, glass crystals in industry 3231, and unbreakable crystals in industry 3079.

3872 Watchcases (S-86; C-97).—Establishments primarily engaged in the manufacture of watchcases, for sale as such. Establishments primarily engaged in assembling complete watches by assembling purchased movements with watchcases of their own manufacture are classified in industry 3871.

39 MISCELLANEOUS MANUFACTURING INDUSTRIES

This major group includes establishments primarily engaged in manufacturing products not classified in any other manufacturing ma-

[or group. Industries in this group fall into the following categories: jewelry, silverware and plated ware; musical instruments; toys, sporting and athletic goods; pens, pencils, and other office and artists' materials; buttons, costume novelties, miscellaneous notions; brooms and brushes; morticians' goods, and other miscellaneous manufacturing industries.

391 JEWELRY, SILVERWARE, AND PLATED WARE:

3911 Jewelry (Precious Metal) (S-92; C-97).—Establishments primarily engaged in manufacturing jewelry and other articles, worn on or carried about the person, made of precious metals with or without stones (including the setting of stones where stones are used), including cigarette cases and lighters, vanity cases and compacts; trimmings for umbrellas and canes; and jewel settings and mountings. Establishments primarily engaged in manufacturing costume jewelry from nonprecious metals and other materials are classified in industry 3961.

3912 Jewelers' Findings and Materials (S-92; C-89).—Establishments primarily engaged in manufacturing unassembled jewelry parts, and stock shap products such as sheet, wire and tubing. Establishments primarily engaged in lapidary work are classified in industry 3913.

3913 Lapidary Work (S-93; C-81).—Establishments of lapidaries primarily engaged in cutting, slabbing, tumbling, carving, engraving, polishing, or faceting stones from natural or man-made precious or semi-precious gem row materials, either for sale or on a contract basis for the trade; in recutting, repolishing, and setting gem stones; or in cutting, drilling, and otherwise preparing jewels for instruments, dies, watches, chronometers, and other industrial uses. This industry includes the drilling, sawing, and peeling of real or cultured pearls, but does not include the manufacture of artificial pearls (industry 3961).

3914 Silverware, Plated Ware, and Stainless Steel Ware (S-95; C-98).—Establishments primarily engaged in manufacturing flatware (including knives, forks, and spoons), hollow ware, toilet ware, ecclesiastical ware, and related products made of sterling silver; of metal plated with silver, gold, or other metal; of nickel silver; of pewter; or of stainless steel.

"Flatware" is defined for purposes of the census as all knives, forks, spoons, etc., made wholly of metal, including stainless steel knives, forks, and spoons, and carving sets with metal handles. Knives, forks, spoons, etc., with handles of materials other than metal are included in industry 3421.

393 MUSICAL INSTRUMENTS:

3931 Musical Instruments (S-97; C-92).—Establishments primarily engaged in manufacturing pianos, with or without player attachments; organs; other musical instruments; and parts and materials for musical instruments.

394 TOYS, AMUSEMENT, SPORTING AND ATHLETIC GOODS:

3941 Games and Toys, Except Dolls and Children's Vehicles (S-92; C-91).—Establishments primarily engaged in manufacturing indoor games and game sets for adults and children, and mechanical and nonmechanical toys. Important products of this industry include games such as chess, checkers, dominoes, puzzles, and other indoor games; and toys, such as toy furniture, doll carriages and carts, construction sets, mechanical trains, toy guns and air rifles, and other mechanical games and toys. Establishments primarily engaged in manufacturing dolls are classified in industry 3942; children's outdoor wheel goods and vehicles, except bicycles, in industry 3943; and sporting and athletic goods for children and adults in industry 3949.

3942 Dolls (S-80-85; C-87).—Establishments primarily engaged in manufacturing dolls, doll parts, and doll clothing. Establishments primarily engaged in manufacturing stuffed toy animals are also included in this industry.

3943 Children's Vehicles, Except Bicycles (S-71; C-65).—Establishments primarily engaged in manufacturing baby carriages, strollers, and go-carts; children's velocipedes and tricycles, coaster wagons, play cars, sleds and other children's outdoor wheel goods and vehicles, except bicycles (industry 3751).

3949 Sporting and Athletic Goods, N.E.C. (S-93; C-91).—Establishments primarily engaged in manufacturing sporting and athletic goods, n.e.c., such as fishing tackle; golf and tennis goods; baseball, football, basketball, and boxing equipment; roller skates and ice skates; gymnasium and playground equipment; billiard and pool tables; and bowling alleys and equipment. Establishments primarily engaged in manufacturing athletic apparel are classified in Major Group 23, small arms ammunition in industry 1961 and firearms in industry 1951.

395 PENS, PENCILS, AND OTHER OFFICE AND ARTISTS' MATERIALS:

3951 Pens, Pen Points, Fountain Pens, Ball Point Pens, Mechanical Pencils and Parts (S-90; C-93).—Establishments primarily engaged in manufacturing pens, pen points, fountain pens, ball point pens, refill cartridges, and parts for pens and mechanical pencils.

3952 Lead Pencils, Crayons, and Artists' Materials (S-87; C-90).—Establishments primarily engaged in manufacturing lead pencils, pencil leads, and crayons; materials and equipment for art work such as airbrushes, drawing tables and boards, palettes, sketch boxes, pantographs, artists' colors and waxes, pyrography goods, drawing inks, and drafting materials. Establishments primarily engaged in manufacturing mechanical pencils are classified in industry 3951, and drafting instruments in industry 3811.

3953 Marking Devices (S-84; C-90).—Establishments primarily engaged in manufacturing rubber and metal hand stamps, dies, and seals; steel letters and figures; and stencils for use in painting or marking.

3955 Carbon Paper and Inked Ribbons (S-95; C-83).—Establishments primarily engaged in manufacturing carbon paper for business machines, soles books, etc.; spirit or gelatin process and other stencil paper; and inked ribbons for business machines.

396 COSTUME JEWELRY, COSTUME NOVELTIES, BUTTONS, AND MISCELLANEOUS NOTIONS, EXCEPT PRECIOUS METAL:

3961 Costume Jewelry and Costume Novelties, Except Precious Metal (S-95; C-95).—Establishments primarily engaged in manufacturing costume jewelry, costume novelties, and ornaments made of all materials, except precious metal, precious or semiprecious stones, and rolled gold plate and gold filled materials (industry 3911).

3962 Feathers, Plumes, and Artificial Flowers (S-97; C-87).—Establishments primarily engaged in manufacturing artificial flowers, fruits, and foliage made from all materials except glass (industry 3231); in producing fancy feathers, plumes, and articles made principally of feathers and plumes; and curling, dyeing, and renovating ostrich feathers for the trade.

3963 Buttons (S-96; C-87).—Establishments primarily engaged in manufacturing buttons, button parts, and button blanks and molds, of all materials except precious metal and precious or semiprecious stones (industry 3911).

3964 Needles, Pins, Hooks and Eyes, and Similar Notions (S-91; C-92).—Establishments primarily engaged in manufacturing notions, such as machine and hand needles, pins, hooks and eyes, eyelets, buckles, and slide and snap fasteners.

399 MISCELLANEOUS MANUFACTURING INDUSTRIES:

3991 Brooms and Brushes (S-89; C-93).—Establishments primarily engaged in manufacturing household, industrial, and street sweeping brooms; and brushes such as paint brushes, toothbrushes, toilet brushes, and household and industrial brushes. This industry under the previous classification system was industry 3981.

3993 Signs and Advertising Displays (S-96; C-95).—Establishments primarily engaged in manufacturing electrical, mechanical cutout, or plate signs and advertising displays, including neon signs and advertising novelties. Sign painting shops doing business on a custom basis are classified in service industries. Establishments primarily engaged in manufacturing electrical signal equipment are classified in industry 3662, and lighting fixtures in industry 3642.

3994 Morticians' Goods (S-95; C-98).—Establishments primarily engaged in manufacturing caskets, coffins, burial cases, and coffin shipping cases, whether of wood or other material, except concrete (industry 3272); morticians' supplies and accessories, such as burial garments, gloves, slippers, casket linings, and embalming fluids; and morticians' paraphernalia and equipment. This industry under the previous classification system was industry 3988.

3996 Linoleum, Asphalted-Felt-Base, and Other Hard Surface Floor Coverings, N.E.C. (S-82; C198).—Establishments primarily engaged in manufacturing linoleum, asphalted-felt-base, and other hard surface floor coverings, n.e.c. Establishments primarily engaged in manufacturing rubber floor coverings are classified in industry 3069, and cork floor and wall tile in industry 2499. Also excluded are establishments primarily engaged in manufacturing unsupported plastic floor coverings (industry 3079), and asphalt tile and vinyl asbestos floor tile (industry 3292). This industry under the previous classification system was industry 3982.

3999 Manufacturing Industries, Not Elsewhere Classified (S-N.A.; C-N.A.).—Establishments primarily engaged in manufacturing miscellaneous fabricated products, including beauty shop and barber

shop equipment; hair work; tobacco pipes and cigarette holders; coin-operated amusement machines; matches; candles; lamp shades; dressed and dyed furs; umbrellas; parasols and canes; and other articles, not elsewhere classified.

The code number for this industry in the Stadard Industriol Clossificatian Manual is unchanged, but the cantent af the Industry has been changed fram the previous classificatian system. The campasitian af the industry as naw canstituted is due principally ta the inclusian af matches (3983); candles (3984); lamp shades (3987); furs, dressed and dyed (3992); and umbrellas, parasols, and canes (3995) in industry 3999.

19 ORDNANCE AND ACCESSORIES

This major graup includes establishments engaged in manufacturing artillery, small arms, and related equipment; ammunitian; complete guided missiles; tanks and specialized tank parts; sighting and fire cantral equipment; and miscellaneous aidnance and accessaries, n.e.c.

191 GUNS, HOWITZERS, MORTARS, AND RELATED EQUIPMENT OVER 30 MM (OR OVER 1.18 INCHES):

1911 Guns, Howitzers, Mortars, and Related Equipment (S-N.A.; C-N.A.).—Establishments primarily engaged in manufacturing naval, aircraft, antiaircraft, tank, coast and field artillery having a bore aver 30 mm (or aver 1.18 inch) and campanents. Establishments primarily engaged in manufacturing small arms and parts 30 mm (or 1.18 inch) and below are classified in industry 1951.

192 AMMUNITION, EXCEPT FOR SMALL ARMS:

1925 Guided Missiles and Space Vehicles, Completely Assembled (S-94; C-69).—Establishments primarily engaged in manufacturing camplete guided missiles and space vehicles and in daing research and develapment an camplete guided missiles and space vehicles. Estabtishments engaged in manufacturing guided missile campanents and in daing research and develapment an guided missile components are classified in industry 3729.

1929 Ammunition, Except for Small Arms, N.E.C. (S-70; C-82).—Establishments primarily engaged in manufacturing ammunition, n.e.c. ar in lading and assembling ammunition over 30 mm (ar aver 1.18 inch) far naval, aircraft, antiaircraft, tank, coast, and field artillery; including campanent parts. This industry also includes establishments primarily engaged in manufacturing bambs, mines, torpedaes, grenades, depth charges, chemical warfare projectiles, and their component parts. Establishments primarily engaged in manufacturing small arms ammunitian are classified in industry 1961; explosives in industry 2892 and military pyrotechnics are classified in industry 2899.

193 TANKS AND TANK COMPONENTS:

1931 Tanks and Tank Components (S-95; C-79).—Establishments primarily engaged in manufacturing or assembling complete tanks, and speciolized components for tanks. Establishments primarily engaged in manufacturing military vehicles other than tanks are classified in Industry Group 371 and tank engines in Industry 3519.

194 SIGHTING AND FIRE CONTROL EQUIPMENT:

1941 Sighting and Fire Cantral Equipment (S-57; C-80).—Establishments primarily engaged in manufacturing sighting and fire cantrol equipment, but which are not engaged in manufacturing optical lenses and prisms. Important products of this industry include bomb sights, percentage carrectars, wind carrectars, directors and sound locatars. Establishments engaged in manufacturing optical lenses and prisms and alsa manufacturing sighting and fire cantral equipment are classified in industry 3831.

195 SMALL ARMS:

1951 Small Arms (S-95; C-82).—Establishments primarily engaged in manufacturing small firearms having a bare 30 mm (ar 1.18 inch) and below, and parts for small firearms. Establishments primarily engaged in manufacturing artillery and mortars having a bore over 30 mm (or 1.18 inch), and components parts are classified in Industry 1911.

196 SMALL ARMS AMMUNITION:

1961 Small Arms Ammunition (S-85-90; C-92).—Establishments primarily engaged in manufacturing ammunition far small arms having a bare of 30 mm (ar 1.18 inch) and below. Establishments primarily engaged in manufacturing ammunition except for small arms are classified in Industry Graup 192; blasting and detonating caps, and safety fuses in Industry 2892; and firewarks in industry 2899.

199 ORDNANCE AND ACCESSORIES, N.E.C.:

1999 Ordnance and Accessories, N.E.C. (S-78; C-69[27]).—This industry camprises establishments primarily engaged in manufacturing ordnance and accessaries, n.e.c.

APPENDIX D:

ECONOMIC DATA RELATING TO DOD PROCUREMENT AND THE U.S. ECONOMY

Table D-1

THE CHANGING COMPOSITION OF FEDERAL EXPENDITURES
FISCAL YFARS 1963, 1970 AND 1973

	$ Billion			Percentage of Total		
	1963	1970	1973	1963	1970	1973
Defense, space, foreign affairs	58.9	87.7	88.0	53	44	34
Older income maintenance programs	28.4	49.8	74.9	25	25	29
Major "Great Society" programs	1.7	21.2	35.7	2	11	14
Commerce, transportation, natural resources	7.6	11.6	16.5	7	6	6
President Nixon's new initiatives	...	...	6.4	..	..	2
Interest (net)	7.7	14.4	15.5	7	7	6
Other programs	7.2	13.6	19.3	6	7	8
Total	111.5	198.3	256.3	100	100	100
Expenditures as a percentage of full employment gross national product						
Total	18.4	20.3	20.5	...	...	...
Total, less defense, space foreign affairs	8.7	11.3	13.4	...	...	...

Source:

The Budget of the United States Government, for fiscal years 1973, 1972, and 1965, see C. L. Schutze, et al., Setting National Priorities, The 1973 budget, Washington, D.C.: The Brookings Institution, 1972.

Table D-2

GOVERNMENT SPENDING RELATIVE TO GROSS NATIONAL PRODUCT
1963, 1965 - 1972

	1963	1965	1966	1967	1968	1969	1970	1971	1972
Total Government Budget+	111.3	118.4	134.7	158.4	178.8	184.6	196.6	211.4	236.6
Gross National Product+	573.4	654.2	721.2	769.8	826.1	897.6	953.2	1,008.5	1,089.5
Government Budget as percentage of GNP	19.4%	18.1%	18.6%	20.6%	21.6%	20.6%	20.6%	21.0%	21.7%
Defense Spending*+	49.7	46.9	54.7	67.9	78.3	78.9	78.0	75.6	76.7
Defense Spending as percentage of GNP	8.7%	7.2%	7.6%	8.8%	9.5%	8.8%	8.2%	7.5%	7.0%
Defense Spending as percentage of government budget	44.7%	39.6%	40.6%	42.7%	43.8%	42.7%	39.7%	35.8%	32.4%

+(In billions of current dollars)
*Excluaes Atomic Energy Program
Source:
The Budget of the U.S. Government, Fiscal Year 1973, Executive Office of the President: Office of Management and Budget, p. 546.

Table D-3

ANNUAL AND AVERAGE GROWTH RATES FOR GOVERNMENT SPENDING, GNP AND DOD EXPENDITURES 1963, 1965-1972

Item	1965	1966	1967	1968	1969	1970	1971	1972	Average Annual Growth Rate
Total Government Budget	6.3%	13.7%	17.5%	12.8%	3.2%	6.5%	7.5%	11.9%	9.0%
Gross National Product	14.0%	10.2%	6.7%	7.3%	8.6%	6.1%	5.8%	8.0%	8.3%
Defense Spending	-5.6%	16.6%	24.1%	15.3%	.7%	-1.1%	-3.0%	1.4%	6.0%

Source:
Table D-2

Table D-4

RELATIVE DOD PROCUREMENT TRENDS
(current dollars)

DOD Procurement	1963	1968	1972	Change in Percentage Points 1963-72
As % of the GNP	2.9	2.8	1.7	- 1.2
As % of the Federal budget	14.9	13.0	7.9	- 7.0
As % of the DOD budget	33.4	29.7	24.5	- 8.9

Source:
Tables D-2 and D-5.

Table D-5

BREAKDOWN OF DOD EXPENDITURES BY YEAR 1963, 1965-1973
(in billions of dollars)

	1963e	1965	1966	1967	1968	1969	1970	1971	1972	1973
NON-DISCRETIONARY:										
Military Personnel	13.0	14.7	16.8	19.8	22.0	23.7	25.9	26.0	26.5	26.6
Operations & Maintenance	11.9	12.4	14.7	19.0	20.6	22.2	21.6	20.9	20.6	20.5
TOTAL NON-DISCRETIONARY	24.9	27.1	31.5	38.8	42.6	45.9	47.5	46.9	47.1	47.1
DISCRETIONARY:										
Procurement	16.6	11.8	14.3	19.0	23.3	24.0	21.6	18.9	18.8	19.3
Research & Development	6.4	6.2	6.3	7.1	7.7	7.5	7.2	7.3	7.8	7.9
Miscellaneous*	1.9	2.1	3.3	3.4	4.8	1.6	1.8	2.6	3.3	5.5
TOTAL DISCRETIONARY:	24.9	20.1	23.9	29.5	35.8	33.1	30.6	28.8	29.9	32.7
Offsetting Receipts	-.1	-.3	-.7	-.4	-.1	-.1	-.1	-.1	-.3	-.7
TOTAL DOD EXPENDITURES	49.7	46.9	54.7	67.9	78.3	78.9	78.0	75.6	76.7	79.1

*Does not include Atomic Energy Program
e = estimated

Source:

The Budget of the U.S. Government, Fiscal Year 1973, Executive Office of the President: Office of Management and Budget, pages 270-291 and 546; and The Budget of the U.S. Government Appendix, Fiscal Year ....

Table D-6

PERCENTAGE BREAKDOWN OF DOD EXPENDITURES
1963, 1965-72

	1963	1965	1966	1967	1968	1969	1970	1971	1972
NON-DISCRETIONARY:									
Military Personnel	26.3%	30.9%	30.8%	29.2%	28.3%	29.6%	33.0%	34.7%	34.6%
Operations & Maintenance	24.0	26.1	26.9	28.0	26.5	27.8	27.5	27.9	26.9
TOTAL NON-DISCRETIONARY	50.3%	57.0%	57.7%	57.2%	54.8%	57.4%	60.5%	62.6%	61.5%
DISCRETIONARY:									
Procurement	33.5%	24.8%	26.2%	28.0%	30.0%	30.0%	27.5%	25.2%	24.5%
Research & Development	12.9	13.1	11.5	10.5	9.9	9.4	9.2	9.8	10.2
Miscellaneous	3.2	5.1	4.6	4.3	5.4	3.3	2.8	2.4	4.3
TOTAL DISCRETIONARY:	49.6%	43.0%	42.3%	42.8%	45.3%	42.7%	39.5%	37.4%	39.0%
TOTAL DOD EXPENDITURES	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source:
Ibid.

Note:
Items may not add to totals due to rounding.

Table D-7

CURRENT AND 1958 REAL DOLLAR EXPENDITURES
IN VARIOUS CATEGORIES
($ Billion)

	Item	1963	1968	1972
Current Dollar	GNP	590.5	865.0	1089.5
	Government Spending	111.3	178.8	236.6
	DOD Budget	49.5	78.0	75.8
	Procurement	16.6	23.3	17.9
1958 Dollar	GNP	551.1	707.3	769.4
	Government Spending	103.1	141.3	150.9
	DOD Budget	45.8	61.7	48.3
	Procurement	15.4	18.4	11.4

Source:
(1) The Budget of the U.S. Government Fiscal Year 1973
(2) Economic Report of the President, 1972

Table D-8

ITEMIZED DOD DIRECT PROCUREMENT FY1971-1973
(in billions of dollars)

Procurement Item	1971	1972	1973
1. Aircraft	3.483	3.517	3.487
2. Modification of aircraft	.834	1.035	.886
3. Spares & repairs	.959	.890	.981
4. Support Equip. & facilities	1.056	1.012	.495
TOTAL DIRECT AIRCRAFT PROCUREMENT	6.332	6.454	5.849
1. Anti-ballistic missile systems	1.697	1,717	1.755
2. Other missiles	.733	.881	.966
3. Modification of missiles	.167	.115	.097
4. Missile spares & repair parts	.116	.122	.128
5. Missile Support equip.	.678	.584	.742
TOTAL DIRECT MISSILE PROCUREMENT	3.391	3.419	3.688
Combat vehicles	.350	.214	.323
Ammunition	2.159	2.439	1.767

(Continued)

Table D-8 (continued)

Procurement Item	1971	1972	1973
1. Fleet ballistic missile ships	.360	.392	.779
2. Other warships	1.524	1.808	2.088
3. Amphibious ships	.313	.100	.010
4. Mine warfare & patrol ships		.005	.251
5. Auxiliary craft	.160	.696	.435
TOTAL DIRECT SHIP PROCUREMENT	2.357	3.001	3.563
Ship Support Equipment	.541	.507	.532
Aviation Support Equipment	.278	.390	.377
Ordnance " "	.896	.703	.836
Supply " "	.628	.728	1.228
Personnel " "	.060	.032	.038
Civil Engr. " "	.049	.040	.050
Communications & Electronics	.838	.762	.904
TOTAL DIRECT SUPPORT & COMMUNICATION	3.290	3.162	3.965
TOTAL DIRECT DOD PROCUREMENT	17.879	18.689	19.155

Source:
The Budget of the U.S. Government Appendix, Fiscal Year 1973, Executive Office of Management and Budget, pp. 296-311.

Note:
Differences from D-5 may result from variations in classification of miscellaneous category. Differences from Table I in text are due to rounding and variations in reporting of individual items.

Table D-9

SHIPMENTS OF DEFENSE-ORIENTED INDUSTRIES TO DOD
BY TWO DIGIT SIC CODE INDUSTRIES

SIC Code	Industry	1967		1970	
		Shipment to DOD as % of the Total Value of Shipment of the Industry*	% of Total DOD Procurement	Shipment to DOD as % of the Total Value of Shipment of the Industry*	% of Total DOD Procurement
19	Ordnance	71.4	18.3	71.6	21.9
28	Chemicals	12.2	1.5	6.4	1.0
2911	Petroleum Refining	3.0	2.0	1.5	1.2
3069	Fabricated Rubber	.6	.6	4.3	.4
33	Primary Metals	4.4	1.8	2.1	1.0
34	Fabricated Metal	5.2	1.2	2.8	.7
35	Machinery	6.9	4.3	4.6	3.8
36	Electrical Equipment	24.5	21.1	22.1	23.6
37	Transportation Equipment	42.7	43.5	53.2	43.9
38	Instruments and Related Products	16.2	3.7	5.6	1.8

Source:
Shipments of Defense-Oriented Industries in 1967 and 1970, U.S. Department of Commerce, Bureau of the Census (August 1969, June 1972).

*Includes only DOD-related industries.

Table D-10

ORDNANCE (SIC 19)
SHIPMENTS TO DOD - 1970

SIC Code	Industry	Value of Shipments*	Percentage of SIC 19
1925	Guided Missiles	$2,545.7	42.0%
1929	Ammunition	2,283.3	37.6
1931	Tanks	278.2	4.6
1941	Sighting & Fire Control	31.4	.5
1951	Small Arms	134.5	2.2
1961	Small Arms Ammunition	413.5	6.8
1911 - 1999	Guns, Mortars; Ordnance & Accessories	379.6	6.3
	Totals	$6,066.2	100.0%

SIC 19 constitutes 21.9 percent of the total shipments to DOD.

Source: Ibid.

*(Millions of dollars)

Table D-11

ELECTRICAL MACHINERY (SIC 36)
SHIPMENTS TO DOD - 1970

SIC Code	Industry	Value of Shipments *	Percentage of SIC 36
3611	Elect. Measur. Instruments	$123.6	1.9%
3612	Transformers	11.8	.2
3613	Switchgear	13.0	.2
3621	Motors & Generators	150.1	2.3
3622	Industrial Controls	20.9	.3
3643	Current Wiring Devices	4.0	.1
3644	Noncurrent Wiring Devices	2.5	-
3661	Telephone & Telegraph	60.6	.1
3662	Radio & TV Comm. Equip.	5,631.2	86.1
3671	Electronic tubes	28.4	.4
3672	Cathode Ray Dic. tubes		
3673	Elect. Tubes	155.1	2.4
3674	Semiconductors	64.2	.9
3679	Elect. Components	180.0	2.7
3691	Storage batteries	22.1	.3
3692	Prime Batteries	30.6	.4
3693	X-ray	4.5	.1
3694	Elect. Engineering Equip.	38.2	.6
3699	Elect. Equip. n.e.c.	1.6	-
	Totals	$6,542.4	100.0%

SIC 36 constitutes 23.6 percent of the total shipments to DOD.

Source:
Ibid.

*(Millions of dollars)

Table D-12

TRANSPORTATION EQUIPMENT (SIC 37)
SHIPMENTS TO DOD - 1970

SIC Code	Industry	Value of Shipments *	Percentage of SIC 37
3713	Truck & Bus Bodies	$ 25.1	.2%
3715	Truck Trailers	16.5	.1
3721	Aircraft	6,298.7	51.8
3722	Aircraft Eng. & Parts	3,039.0	25.0
3729	Aircraft Equipment	1,578.6	13.0
3731	Ship Building	1,210.6	10.0
	Totals	$12,168.5	100.0%

SIC 37 constitutes 43.9 percent of the total shipments to DOD.

Source:
Ibid.

*(Millions of dollars)

Table D-13

CONCENTRATION OF DOD PROCUREMENT IN TOP 100 COMPANIES
(Percentage of DOD Procurement)

Companies	FY 1969	FY 1970	FY 1971	FY 1972
1st	5.5%	5.9%	5.1%	5.1%
2nd	4.4	3.8	5.0	5.1
3rd	3.4	3.2	4.0	3.9
4th	2.9	3.0	3.7	3.7
5th	2.7	2.8	3.5	3.5
1 - 5	18.9%	18.7%	21.3%	21.3%
6 - 10	10.1	10.5	13.5	13.9
11 - 25	15.8	16.8	17.3	16.0
1 - 25	44.8%	46.0%	52.1%	51.2%
26 - 50	12.1	13.3	11.0	11.5
51 - 75	7.3	6.6	5.8	6.0
76 - 100	4.0	3.8	3.2	3.4
1 - 100	68.2%	69.7%	72.1%	72.1%

Source:

100 companies (companies receiving the largest dollar volume of prime contract awards) FY 1972, Department of Defense, 6 October 1972.

Table D-14

TOTAL DOLLAR VALUE AND PERCENT OF TOTAL PROCUREMENT IN EACH CATEGORY: FOUR LARGEST MILITARY CONTRACTORS, FISCAL YEAR 1966*

Market Category	Procurement from Largest 4 Military Contractors (In Thousands)	Percent of Total
1. Small arms	146,440	67.5
2. Heavy weapons	42,827	27.1
3. Optical fire control equip	10,358	52.0
4. Ammunition and misc ordnance	490,410	20.0
5. Guided missiles	1,478,195	36.5
6. Aircraft	2,427,483	59.3
7. Propellers	51,994	97.9
8. Acft components and supports	449,761	42.1
9. Ships and boats	364,943	42.6
10. Marine hardware	5,541	69.8
11. Locomotives	2,422	98.6
12. Rail cars	4,125	100.0
13. Motor vehicles, noncombat	556,189	58.0
14. Tanks and combat vehicles	278,278	66.5
15. Tractors and constr equip	104,722	51.1
16. Tires and tubes	42,803	56.2
17. Engines and components, nonacft	204,595	69.8
18. Turbines	49,479	92.2
19. Engine electrical systems	33,416	54.8
20. Engines and components, acft	1,861,775	87.3
21. Mech and power trans equip	4,796	66.0
22. Bearings	10,515	44.8
23. Woodworking mach	1,144	66.1
24. Metal-cutting machine tools	27,797	34.7
25. Electrical welding equip	4,473	67.9
26. Gas welding equipment	1,991	38.1
27. Metal-forming machine tools	5,615	39.9
28. Machine tool accessories	881	65.2
29. Special dies and tools	683	97.4
30. Laundry equipment	9,805	64.9
31. Service industry machines	2,798	64.4
32. Sewing machines	1,318	95.5
33. Printing machinery	3,754	45.2
34. Miscellaneous machinery	12,010	63.7
35. Agricultural machinery	3,124	56.6
36. Conveyors	9,411	23.9
37. Warehouse trucks	59,315	70.4
38. Hoists and cranes	6,524	45.1
39. Elevators	631	91.6
40. Chain and wire rope	4,194	37.0
41. Fibre cordage	3,923	43.1
42. Cable fittings	1,677	58.1
43. Refrigeration and acft equip	20,226	25.4
44. Fire-fighting and safety equip	21,337	25.3
45. Pumps and compressors	13,890	35.6
46. Boilers and nuclear reactors	178,658	95.7
47. Industrial furnaces	2,980	51.1
48. Fans and blowers	2,360	42.2
49. Plumbing fixtures	3,120	46.5
50. Heating equipment	5,571	57.1
51. Water treatment equipment	5,449	60.4
52. Pipe and tubing	25,698	27.1
53. Valves	7,242	29.8
54. Maintenance equip and tools	33,482	22.4
55. Measuring tools	648	58.6
56. Hardware and abrasives	9,821	22.4
57. Structural wood products	1,659	55.0
58. Bridges	9,874	81.5
59. Storage tanks	7,488	68.5
60. Prefabricated metal structures	22,072	52.1
61. Lumber and millwork	12,123	23.9
62. Plywood	5,830	42.1
63. Construction materials, mineral	6,371	21.5
64. Construction materials, matel	96,099	34.4
65. Telephonic equipment	66,553	38.2
66. Sound equipment	15,555	56.1
67. Electronic equipment	663,338	21.2
68. Electronic and electrical comp	50,011	24.4
69. Switchgear and connectors	3,847	11.9
70. Electron tubes	63,780	41.0
71. Motors and generators	50,462	32.1
72. Power devices and controls	36,481	43.2
73. Transformers	2,604	80.9
74. Batteries	61,004	56.5
75. Electric wire and cable	35,613	45.3
76. Lighting fixtures	11,633	31.0
77. Drugs and medicines	36,570	31.8
78. Medical supplies	11,750	26.4
79. Dental equipment	2,458	47.9
80. X-Ray equipment	10,715	65.3
81. Opthalmic goods	5,593	88.3
82. Scientific and navigation instr	265,98[illegible]	59.4
83. Analysis and measuring instr	18,522	37.3
84. Temperature and pressure contr	5,569	35.9
85. Optical instruments	5,383	40.6
86. Electrical measuring instr	47,472	33.4
87. Timers	1,966	45.5
88. Photographic equipment	74,721	55.2
89. Chemicals	37,869	32.3
90. Household furniture	13,727	59.3
91. Office and hospital furniture	12,516	32.2
92. Furnishings	23,661	25.3
93. Food preparation equipment	5,254	29.6
94. Kitchen tools and cutlery	4,143	39.0
95. Tableware	1,853	75.9
96. Computers and office machines	217,169	83.4
97. Typewriters	3,181	60.4
98. Office supplies	5,2[illegible]5	29.6
99. Books and papers	11,946	41.0
100. Musical supplies and phonographs	450	45.0
101. Recreational equipment	777	61.6
102. Cleaning equipment and supplies	12,444	57.8
103. Paint	1,682	36.0
104. Bags and sacks	23,800	49.6
105. Drums and cans	10,167	88.8
106. Boxes and cartons	36,825	31.1
107. Gas cylinders	1,303	100.0
108. Fabrics	156,795	42.6
109. Yarn and thread	244	71.3
110. Apparel findings	1,876	56.7
111. Leather	904	86.1
112. Shoe findings and stock	1,710	85.4
113. Tents and tarpaulins	19,172	46.5
114. Flags and misc textiles	15,286	30.1
115. Men's outerwear	43,587	13.3
116. Women's outerwear	1,397	62.0
117. Special clothing	19,028	27.0
118. Men's underwear and nightwear	18,278	43.7
119. Footwear	55,335	42.5
120. Hosiery and gloves	13,168	51.4
121. Badges and insignia	4,852	51.0
122. Luggage	6,711	57.7
123. Toiletries	2,732	54.0
124. Toilet tissue	3,926	76.5
125. Meat, poultry, fish	70,110	26.4
126. Dairy foods and eggs	33,706	18.8
127. Fruits, vegetables, preserves	23,621	14.9
128. Bakery and cereal products	14,380	24.8
129. Sugar and confectionery	17,411	60.5
130. Soaps and specialties	11,526	35.5
131. Fats and oils	10,725	61.2
132. Miscellaneous prepared foods	14,853	33.6
133. Coffee, tea, cocoa	29,754	54.3
134. Beverages, nonalcoholic	2,936	34.5
135. Beverages, alcoholic	3,928	59.6
136. Tobacco products	29,896	85.7
137. Chamical fuels	49,562	55.0
138. Petroleum fuels and oils	391,815	31.1
139. Paper and paperboard	11,366	71.7
140. Plastic materials	3,278	58.9
141. Refractory materials	765	45.1
142. Metal bars, sheets, shapes	21,[illegible]57	31.7
143. Signs	722	54.3
144. Matches	338	75.8
145. Mortuary goods	729	76.3
146. Miscellaneous services	107,520	23.1
147. Operation and maintenance	345,241	38.8
148. Architect-engineer services	129,476	24.7
149. Housekeeping services	212,368	43.7
150. R&E services, unassigned	179,522	20.9
151. Transportation services	167,875	19.3
152. Constr and property maint	631,320	35.8
153. Agricultural supplies	905	56.5
154. Nonmetallic crude materials	4,063	50.0
155. Ores, minerals and their products	7,246	72.5
156. Perishable subsistence	NA	NA[a]
157. Unassigned and miscellaneous	27,155	33.4

SOURCE: Data procurement reports from military services and OSA (D00-350 tapes).

[a]Assumed to be under 10 percent.

*McKie, James W., Concentration in Military Procurement Markets: A Classification and Analysis of Contract Data, June 1970, The Rand Corporation, RM-6307-PR.

Table D-15

SELECTED CONCENTRATION RATIOS FOR MANUFACTURED PRODUCT GROUPS, 1963; AND MANUFACTURING INDUSTRIES, 1966: LARGEST FOUR SELLERS*

Product Class or Group (SIC/Census Code)	Concentration Ratio, 1963	Industry (SIC/Census Code)	Concentration Ratio, 1966	Product Class or Group (SIC/Census Code)	Concentration Ratio, 1963	Industry (SIC/Census Code)	Concentration Ratio, 1966
2011-	30	2011	27	2511-	10	2511	12
2013-	14	2013	16	2512-	12	2512	15
2015-	13	2015	17	2514-	12	2514	13
20156	33			2515-	23	2515	27
20210	8			25190	18		
2022-	45	2022	44	2522-	29	2522	37
2023-	33	2023	45	2531-	21	2531	24
20240	34	2024	33	25410	4	2541	4
20310	33	2031	42	25420	19	2542	22
2032-	69	2032	63	2591-	34	2591	41
2033-	24	2033	24	2643-	23	2643	23
20341	39			26451	37		
2036-	23	2036	33	26452	27		
2037-	23	2037	24	26461	90		
20430	82			26472	61		
2052-	58	2052	59	26491	30		
20620	62	2062	63	26510	21	2651	22
20630	66	2063	68	26520	10	2652	12
2071-	15	2071	24	2655-	51	2655	54
2072-	71	2072	78	2661-	42	2661	45
20820	34	2082	39	2731-	18	2731	20
20840	50	2084	41	2812-	56	2812	63
2085-	58	2085	55	2813-	71	2813	72
20860	11	2086	14	2815-	45	2815	52
2095-	54	2095	54	2818-	42	2818	46
2096-	41	2096	47	2819-	27	2819	29
2099-	26	2099	26	2831-	37	2831	46
20999	23			2833-	51	2833	70
21110	80[a]	2111	81	2834-	22	2834	24
21210	59	2121	58	2841-	68	2841	72
21310	53	2131	59	2842-	30	2842	30
		2211		2844-	33	2844	40
		2221		2851-	24	2851	23
2231-	46	2231	56	28921	70		
2241-	15	2241	23	2899-	14	2899	20
2252-	16	2252	22	2911-	32	2911	32
2254-	30	2254	33	29523	45		
22720	25	2272	26	2992-	36	2992	36
2281-	16	2281	19	3011-	72	3011	71
2283-	24	2282	29	30210	62	3021	63
2284-	63	2284	62			3079	8
2298-	30	2298	38	3111-	20	3111	19
2311-	13	2311	17	31310	18	3131	19
23214	23			3141-	25	3141	26
23215	33			31610	30	3161	35
23221	39			32550	42	3255	41
2327-	14	2327	20	3259-	34	3259	33
2328-	25	2328	28	32620	62	3262	75
2329-	16	2329	28	32630	52	3263	61
2337-	4	2337	9	3275-	82	3275	80
2339-	12	2339	14	3291-	49	3291	56
2381-	30	2381	27	32924	78		
23850	21			32925	79		
23860	24			32926	69		
2387-	16	2387	28			3312	49
23890	17			33126	61		
23910	21			33151	72		
		2392		33156	51		
23940	16	2394	19	3316-	38	3316	34
2396-	58	2396	58	33176	25		
23990	14	2399	16	3351-	45	3351	43
2421-	10	2421	11	3352-	67	3352	65
2432-	21	2432	24	3357-	42	3357	39
2433-	25	2433	22	3421-	66	3421	66
2441-	14	2441	23	3423-	17	3423	22

(continued)

Table D-15, cont'd.

Product Class or Group (SIC/Census Code)	Concentration Ratio, 1963	Industry (SIC/Census Code)	Concentration Ratio, 1966	Product Class or Group (SIC/Census Code)	Concentration Ratio, 1963	Industry (SIC/Census Code)	Concentration Ratio, 1966
34291	70[a]			3613-	48	3613	52
34294	26			3621-	47	3621	48
3429[illegible]	13			36220	49	3622	50
34310	46	3431	47	3623-	36	3623	38
34320	27	3432	32	3629-	31	3629	33
3433-	14	3433	16	36360	82	3636	80[a]
3441[illegible]	13			3642-	15	3642	18
34412	40			36511	51		
34431	24			36513	16		
34433	79			36520	68	3652	71
34434	62			3661-	80[a]	3661	94
34438	24			3662-	30	3662	24
3449-	24	3449	24	36710	83	3671	95
3452-	17	3452	18	3679-	11	3679	22
34614	71			3691-	60	3691	60
34615	43			36920	83	3692	88
3481-	12	3481	13	36930	49	3693	67
34811	55			3694-	68	3694	72
3491-	41	3491	39	37170	60	3717	79
3494-	13	3494	13	3721-	58	3721	67
34941	25			37221	97		
34942	25			37222	80[a]		
34943	27			37223	87		
34944	20			37224	53		
34980	14	3498	13	37225	82		
34990	16	3499	16	37226	89		
3511-	83	3511	87	37227	95		
3519-	46	3519	5[illegible]	37230	87	3723	96
3522-	4[illegible]	3522	45	37291	28		
3531-	42	3531	45	37293	82		
35340	55	3534	63	37294	61		
3535-	23	3535	29	3731-	48	3731	42
3536-	27	3536	44	3732-	21	3732	20
35370	49	3537	49	3741-	92	3741	98
3541-	21	3541	22	3742-	52	3742	50
3542-	20	3542	24	3811-	28	3811	29
3545-	14	3545	20	3821-	19	3821	21
35452	39			38220	58	3822	59
35482	43			3831-	37	3831	56
35483	66			38311	43		
35484	38			38312	58		
3553-	30	3553	32	38410	34	3841	40
3555-	39	3555	46	38421	52		
3561-	23	3561	27	38423	44		
3562-	57	3562	56	38430	37		
3564-	20	3564	25	38510	45	3851	60
3566-	19	3566	25	3861-	62	3861	67
3567-	23	3567	35	3871-	42	3871	45
35690	12	3569	21	3931-	37	3931	36
3571-	63			39410	12	3941	22
35720	79	3572	79	3949-	33	3949	29
35790	46	3579	57	39610	13	3961	25
35820	43	3582	51	39811	11		
		3585	34	3982-	85	3982	98
35891	23			39830	70	3983	69
35892	23			3988-	17	3988	22
3611-	30	3611	36	3993-	5	3993	6
3612-	65	3612	66	39991	72		

SOURCE: U.S. Bureau of the Census, Concentration Ratios in Manufacturing Industry, 1963, and Value-of-shipment Concentration Ratios by Industry, 1966.

[a]A minimum estimate. Actual figure not disclosed.

*McKie, James W., Concentration in Military Procurement Markets: A Classification and Analysis of Contract Data, June 1970, The Rand Corporation, RM-6307-PR.

Table D-16

AMOUNT OF MILITARY PRIME CONTRACT AWARDS, FISCAL 1967, AND THEIR PERCENTAGE OF TOTAL SALES, CALENDAR 1967: 100 LARGEST DEFENSE CONTRACTORS IN FISCAL 1967*

Cootractor	Military Prime Contracts FY 1967 ($ million)	Corporate Sales Caleodar 1967 ($ million)	Contracts as Percentage of Sales	Contractor	Military Prime Contracts FY 1967 ($ millioo)	Corporate Sales Calendar 1967 ($ million)	Cootracts as Percentage of Sales
1. McDonnell Oouglas	2,124.6	2,993.8	71.0	50. Sanders Associates	124.0	139.2	89
2. Geoeral Dynamics	1,831.9	2,253.3	81.3	51. TRW, Inc	120.5	1,214.4	9.9
3. Lockheed Aircraft	1,807.2	2,335.5	77.3	52. Asiatic Petruleum Corp	117.2	NA	NA
4. General Electric	1,289.8	7,737.3	16.7	53. Signal Oil	116.8	1,505.4	7.8
5. United Aircraft	1,097.1	2,214.7	49.5	54. Harvey Aluminum	116.5	147.3	79.1
6. Boeing Company	911.7	2,879.7	31.7	55. Pan American Airways	115.1	944.6	12.2
7. North Americao Rockwell	688.8	2,438.5	28.2	56. Mobil Oil Corp	109.3	5,771.8	1.9
8. AT & T	493.8[a]	3,733.9[a]	13.2[a]	57. Eastman Kodak	108.7	2,391.5	4.5
	673.0[b]	13,009.2[b]	4.0[b]	58. Mason & Hanger	108.4	NA	NA
9. General Motors	625.1	20,026.3	3.1	59. Pacific Archltects	106.9	NA	NA
10. Llog-Temco-Vought	534.7	1,841.1	29.0	60. Lear Slegler	100.8	402.3	25.0
11. Textron, Ioc	496.6	1,446.0	34.3	61. Magnavox	98.5	464.3	21.2
12. Grumman Aircraft	487.7	969.7	50.3	62. Mass Inst of Tech	94.9	NP	NP
13. Sperry Rand	484.1	1,487.1	32.6	63. Am Machine & Foundry	94.1	409.2	23.0
14. RMK-BRJ	462.5	950.0+[c]	49-[c]	64. Texas Instrumeots	93.7	568.5	16.5
15. Westinghouse Electric	453.1	2,900.7	15.6	65. Fairchild Hiller	93.5	268.7	34.8
16. Avco Corporation	448.6	783.0	57.2	66. Curtiss Wright	90.8	173.7	52.3
17. Hughes Aircraft	419.5	NA	NA	67. Teledyne, Inc	87.8	451.0	19.5
18. Ford Motor Compaoy	403.8	10,515.7	3.8	68. Olllingham	87.6	206.9	42.3
19. Raytheoo	403.3	1,106.0	36.5	69. Chamberlain Corp	74.0	85.1	87.0
20. Hooeywell, Inc	313.7	1,044.9	30.0	70. Flying Tlger Line	73.4	87.0	84.4
21. Northrop	306.4	469.4	65.3	71. International Harvester	72.7	2,541.9	2.8
22. Kaiser Industries	305.7[d]	808.7[d]	37.8[d]	72. Federal Cartridge	72.4	NA	NA
23. Beodix	296.1	1,274.0	23.2	73. Johns Hopkins Univ	71.1	NP	NP
24. Martin Marietta	290.2	695.6	41.7	74. Aerospace Corporation	70.8	NP	NP
25. Ryao	290.1	393.2	73.8	75. Oow Chemical	67.0	1,382.7	4.8
26. General Tire	273.1	954.5	28.6	76. Continental Airlines	65.7	188.2	34.9
27. RCA	268.4	3,014.0	8.9	77. White Motor Corporation	64.7	769.8	8.4
28. IT & T	255.2	2,586.3	9.9	78. Condex Corporation	63.0	75.0	84.0
29. Ogden Corporation	236.7	704.1	33.6	79. Western Union	62.4	336.8	18.5
30. Standard Oil (N.J.)	235.1	13,266.1	1.8	80. Emersoo Electronic	62.2	395.2	15.7
31. Uniroyal	217.3	1,264.7	17.2	81. Firestone Tire	61.3[e]	1,875.4	3.3
32. Collios Radio	201.6[e]	439.0	5 9	82. Bethlehem Steel	60.3	2,594.0	2.3
33. Hercules, Inc	195.2	642.6	30.4	83. Airlift International	59.0[e]	70.2	84.0
34. IBM	194.9	5,345.3	3.6	84. Hughes Tool Company	58.6	NA	NA
35. Newport News	188.5	305.3	61.7	85. Cessna Aircraft	56.7	213.6	26.5
36. Litton Industries	180.3	1,561.5	11.5	86. Atlantic Research	56.5	NP	NP
37. Du Pont	179.6	3,078.8	5.8	87. Sverdrup & Parcel	56.5	NA	NA
38. Thiokol	172.7	235.7	73.3	88. American Mfg Company	54.9	794.2	6.7
39. FMC Corporatioo	169.7	1,313.0	12.9	89. Stevens (J.P.) & Co	53.4	794.2	6.7
40. Chrysler Corporatioo	164.7	6,213.4	2.7	90. Vinnell Corp	53.1	NA	NA
41. Goodyear Tire	154.5	2,637.7	5.9	91. Westinghouse Air Brake	51.9	305.4	17.0
42. Olio Matnieson	154.3	901.1	17.1	92. Sy. tem Development Corp	50.4	NP	NP
43. Standard Oil (Calif)	152.8	3,297.8	4.6	93. Northwest Airlines	50.3	384.0	13.1
44. Oay & Zimmerman	142.2	NA	NA	94. Gulf Oil Corporation	49.9	4,202.1	1.2
45. General Telephone	120.2[f]	822.9[f]	16.8[f]	95. Smith, A. O. Corp	48.5	330.0	14.7
	138.5[g]	2,622.1[g]	5.3[g]	96. Motorola	47.8	630.0	7.6
46. Morrison-Knudsen	135.7[d]	189.3	71.7	97. Cities Service	47.5	1,374.9	3.5
47. Norris Industries	127.6[e]	189.9	67.2	98. Tumpane Company	46.9	NA	NA
48. General Precision Equip	124.2	461.6	26.9	99. Union Carbide	46.8	2,545.6	1.8
49. Texaco, Inc.	124.2	5,121.4	2.4	100. Maxson Electronics	46.0	65.7	70.0

Total, 100 companies and subsidiaries	25,693.1
U.S. total, military prime contract awards of $10,000 or more	39,219.4
Perceotage of total going to largest 100	65.5
Percentage of total goiog to largest 10	29.6

SOURCES: Moody's Industrials; Department of Oefense, 100 Companies aod Their Subsidiary Corporations Listed According to Net Value of Military Prime Contract Awards, Fiscal Year 1967.

NOTES: NA iodicates not available, NP indicates noo-profit contractor.

[a] Westero Electric ooly. AT&T was placed in the 5 to 20 percent buyer-coverage bracket.

[b] AT&T consolidated total.

[c] Represeots coosolidation of several numbers of the consortium, but not all.

[d] Iocludes ½ of National Steel and Shipbuilding.

[e] Fiscal year on other than calendar year basis.

[f] Sylvania ooly. General Telephone was placed in the 6 to 20 percent buyer-coverage bracket.

[g] Geoeral Telephone consolidated total

*McKie, James W., Concentration in Military Procurement Markets: A Classification and Analysis of Contract Data, June 1970, The Rand Corporation, RM-6307-PR.

Table D-17

COMPOSITION OF MANPOWER BY TYPE OF WORK (OPERATION)

Type of Work (Operation)	Industry: Aircraft and Parts (SIC 372) [Census of Manufacturers Scope, Adjusted for Under-resorting] Numbers					% Distribution (Production Workers = 100.00)				
	1958	1963	1967	1969	1970	1958	1963	1967	1969	1970
All Employees	765,500	676,700	802,000	773,100	644,900	153.28	174.10	163.91	173.46	179.29
- Non-production employees	266,100	286,400	312,700	327,400	265,200	53.28	74.10	63.91	73.46	79.29
-- R&D (scientists, engineers and technicians)		69,400	75,700	75,800	64,600		17.90	15.47	17.01	17.96
-- Other technical[a]		48,800	55,900	59,900	61,200		12.59	11.42	13.44	17.01
-- Admin.,sales and clerical		168,200	181,100	191,700	159,400		43.61	37.01	43.01	44.31
- Production workers, total	499,400	390,300	489,300	445,700	359,700	100.00	100.00	100.00	100.00	100.00
-- Foundry patterns making	1,990	1,132	2,197			0.40	0.29	0.45		
-- Ferraus foundry	474	273	311			0.09	0.07	0.06		
-- Non-ferrous foundry	821	507	723			0.16	0.13	0.15		
-- Tool and die making	22,594	16,744	21,703			4.52	4.29	4.44		
-- Forging, pressing, upsetting	1,398	1,444	3,341			0.28	0.37	0.68		
-- Parts fabricatian af steel	25,809	12,021	10,454			5.17	3.08	2.14		
-- Stamping	15,899	11,085	16,157			3.18	2.84	3.30		
-- Plastics modling	NA*	3,435	4,166			*	0.88	0.85		
-- Heat treatment	2,875	2,147	3,524			0.58	0.55	0.72		
-- Plating and galvanizing	1,845	1,912	4,157			0.37	0.49	0.85		
-- Automatic screw machine d-t	2,298	1,132	1,746			0.46	0.29	0.36		
-- Machining (shop)	85,995	64,634	103,679			17.22	16.56	21.19		
-- Printing, lacquering, etc.	5,135	4,332	6,558			1.03	1.11	1.34		
-- Assembly of products	*	71,347	111,077			*	18.28	22.70		
-- All ather operatians[b]	332,267	198,155	199,507			66.53	50.79	40.77		

[a]Includes scientists, engineers and technicians warking in management other than R&D, sales, and ather not strictly technical functions.

[b]Maintenance, staroge (warehausing), intraplant materials handling, shipping, quality control, etc.

*Including plastics malding

Saurce: Census af Manufacturers, Bureau of Labor Statistics and Natianal Science Foundatian.

Table D-18

COMPOSITION OF MANPOWER BY TYPE OF WORK (OPERATION)

Type of Work (Operation)	Industry: Radio, TV, Communications Equipment and Electronics [Census of Manufacturers Scope, Adjusted for Under-reporting]									
	Numbers					% Distribution (Production Workers = 100.00)				
	1958	1963	1967	1969	1970	1958	1963	1967	1969	1970
All Employees	498,826	846,600	1,045,400	1,050,900	990,200	142.45	154.45	150.61	156.80	165.09
- Non-production employees	148,654	298,475	351,300	380,700	390,400	42.45	54.45	50.61	56.80	65.09
-- R&D (scientists, engineers, and technicians)		88,100	91,100	87,400	85,700		16.07	13.12	13.04	14.29
-- Other technical[a]		76,400	75,800	88,000	94,500		13.94	10.92	13.13	15.76
-- Admin., sales and clerical		133,975	184,400	205,300	210,200		24.44	26.57	30.63	35.05
- Production workers, Total	350,172	548,125	694,100	670,200	599,800	100.00	100.00	100.00	100.00	100.00
-- Foundry pattems making										
-- Ferrous foundry										
-- Non-ferrous foundry	289	612	433			0.08	0.11	0.06		
-- Tool and die making	3,284	9,350	10,236			0.94	1.71	1.47		
-- Forging, pressing, upsetting										
-- Parts fabricatian of steel	3,785	2,525	5,146			1.08	0.46	0.74		
-- Stamping	9,004	11,142	12,497			2.57	2.03	1.80		
-- Plastics malding	2,020	3,837	7,258			0.58	0.70	1.05		
-- Heat treatment	1,713	1,185	1,026			0.49	0.22	0.15		
-- Ploting and galvanizing	1,754	4,348	6,395			0.50	0.79	0.92		
-- Automatic screw mochine d-t	1,877	2,909	4,198			0.54	0.53	0.60		
-- Machining (shop)	17,168	33,710	35,645			4.90	6.15	5.14		
-- Painting, lacquering, etc.	3,803	3,230	4,116			1.09	0.59	0.59		
-- Assembly of products	203,467	343,617	453,305			58.10	62.69	65.31		
-- All other operotions[b]	102,008	131,660	153,844			29.13	24.02	22.16		

[a] Includes scientists, engineers ond technicians working in management other than R&D, sales ond other not strictly technical functions.

[b] Maintenonce, storoge (warehousing), intraplant materials handling, shipping, quality control, etc.

Source: Census of Manufacturers, Bureau of Labor Statistics, Nationol Science Foundation.

Table D-19

COMPOSITION OF MANPOWER BY TYPE OF WORK (OPERATION)

Type of Work (Operation)	Industry: Motor Vehicles and Equipment (SIC 371) [Census of Manufacturers Scope, Adjusted for Under-reporting]									
	Numbers					% Distribution (Production Workers = 100.00)				
	1958	1963	1967	1969	1970	1958	1963	1967	1969	1970
All Employees	581,700	693,821	739,400	817,300	720,200	125.91	121.50	122.11	120.30	124.15
- Non-production employees	119,700	122,795	33,900	137,900	140,100	25.91	21.50	22.11	20.30	24.15
-- R&D (scientists, engineers and technicians)		11,300	20,500	17,100	16,400		1.98	3.39	2.52	2.83
-- Other technical[a]		20,200	29,800	31,900	33,600		3.54	4.92	4.70	5.79
-- Admin., sales and clerical		91,295	83,600	88,900	90,100		12.45	13.81	13.09	15.53
- Production workers, total	462,000	571,026	605,500	679,400	580,100	100.00	100.00	100.00	100.00	100.00
-- Foundry patterns making	1,426	896	468			0.31	0.16	0.08		
-- Ferrous Foundry	8,108	8,022	4,565			1.75	1.40	0.75		
-- Non-ferrous foundry	1,059	1,433	1,394			0.23	0.25	0.23		
-- Tool and die making	27,794	27,241	20,742			6.02	4.77	3.43		
-- Forging, pressing, upsetting	2,960	4,107	2,571			0.64	0.72	0.42		
-- Parts fabrication of steel	7,956	5,384	4,132			1.72	0.94	0.68		
-- Stamping	61,538	69,857	37,975			13.32	12.23	6.27		
-- Plastics molding	386	670	2,009			0.08	0.12	0.33		
-- Heat treatment	4,148	4,540	4,993			0.90	0.80	0.82		
-- Plating and galvanizing	3,661	4,045	3,002			0.79	0.71	0.50		
-- Automatic screw machine d-t	3,644	3,677	4,205			0.79	0.64	0.69		
-- Machining (shop)	74,850	76,028	82,338			16.20	13.31	13.60		
-- Painting, lacquering, etc.	15,515	26,610	21,660			3.36	4.66	3.58		
-- Assembly of products	248,955	296,997	240,087			53.89	52.01	39.65		
-- All other operations[b]		41,519	175,359				7.27	28.96		

[a] Includes scientists, engineers and technicians working in management other than R&D, sales and other not strictly technical functions.

[b] Maintenance, storage (warehousing), intraplant materials handling, shipping, quality control, etc.

Source: Census of Manufacturers, Bureau of Labor Statistics, National Science Foundation.

Table D-20

TOTAL LABOR REQUIREMENTS IN PRODUCTION OF AIRCRAFT AND PARTS BY TYPE OF WORK (OPERATION), 1963 (Adjusted for Transfers, SIC 372)

Value of output (Net) $12,055 million Type of Work	Intramural (Industry's) Employment	% of Prod. Workers	Total (Direct and Indirect) Employment Associated with Supplies from Industry:											Approximate Total Employment (Direct and Indirect)	
			Primary Metals (SIC 33)	Fab'd. Metal Products (SIC 34)	Ordn. (SIC 19)	Radio, TV, Comm., Engr., & Elect. (SIC 365 -367)	Aircraft & Parts (SIC 372)	Other Engr. Products (SIC 35, 38, excl. cal.586)	Chem. & Related Parts (SIC 28)	Trans. & Comm.	All Other Supplies of Parts & Serv.	All Supplies Number	Total Number Direct Employment	Number	% of Produc. Workers
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
All Employees	674,926	174.10	52,947	31,056	10,406	46,563	-	75,188	4,794	24,840	188.773	434,566	125.69	1,109,492	151.28
- Non-production employees	287,266	74.10	9,606	6,839	5,203	16,416	-	18,796	1,711	2,906	27,333	88,810	25.69	376.076	51.28
-- R&D (scientists, engineers and technicians)	69,400	17.90	343	293	1,702	4,846	-	2,727	351	9	348	10,619	3.07	80,019	10.91
-- Other technical	48,800	12.59	1,833	1,208	1,547	4,202	-	5,177	441	395	1,754	16,557	4.79	65,357	8.91
— Admin., sales, & clerical	169,066	43.61	7,430	6,547	1,954	7,369	-	10,892	920	2,503	25,230	62,845	18.18	231,911	31.62
- Production workers, total	387,660	100.00	43,341	24,217	5,203	30,147	-	56,385	3,082	21,934	161,441	345,751	100.00	733,411	100.00
— Foundry patterns	1,120	0.29	264	50	4	-	-	256	-	-	-	574	0.17	1,694	0.23
— Ferrous foundry	260	0.07	7,370	364	2	-	-	811	-	-	-	8,547	2.47	8,807	1.20
-- Non-ferrous foundry	485	0.13	2,300	315	7	34	-	260	-	-	-	2,916	0.84	3,401	0.46
— Tool and die making	16,634	4.29	303	702	268	514	-	2,615	-	-	-	4,402	1.27	21,036	2.87
— Forging, pressing, upsetting	1,426	0.37	1,133	136	12	-	-	214	-	-	-	1,495	0.43	2,921	0.40
— Parts fabrication of steel	11,954	3.08	117	2,764	344	139	-	2,018	-	-	-	5,382	1.56	17,336	2.36
— Stamping	11,090	2.84	499	5,279	184	613	-	3,764	-	-	-	10,309	2.98	21,339	2.91
— Plastics molding	3,400	0.88	-	-	42	211	-	163	-	-	-	416	0.12	3,816	0.52
— Heat treatment	2,117	0.55	421	184	30	65	-	427	-	-	-	1,127	0.33	3,244	0.44
— Plating and galvonizing	1,904	0.49	254	1,939	61	239	-	349	-	-	-	5,000	1.45	6,904	0.94
— Automatic screw machine d-t	1,111	0.29	29	1,052	54	160	-	637	-	-	-	1,932	0.56	3,043	0.41
— Machining	64,211	16.56	1,546	2,267	534	1,854	-	10,803	-	-	-	17,004	4.92	81,215	11.07
— Painting, lacquering, etc.	4,300	1.11	-	772	84	178	-	1,539	-	-	-	2,573	0.74	6,873	0.94
-- Assembly of products	70,849	18.28	-	1,579	946	18,899	-	18,553	-	-	-	39,977	11.56	110,826	15.11
-- All other operations	196,889	50.79	29,104	6,814	2,632	7,241	-	13,974	-	-	-	246,222	71.21	443,111	60.42

Source: Census of Manufacturers, Bureau of Labor Statistics, National Science Foundation.

Table D-21

TOTAL LABOR REQUIREMENTS IN PRODUCTION OF RADIO, TV, COMMUNICATIONS EQUIPMENT AND ELECTRONICS (SIC 365-7) BY TYPE OF WORK (OPERATION), 1963 (Adjusted for Transfers)

Value of output (Net) $12,055 million Type of Work	Intramural (Industry's) Employment	% of Prod. Workers	Total (Direct and Indirect) Employment Associated with Supplies from Industry:											Approximate Total Employment (Direct and Indirect)	
			Primary Metals (SIC 38)	Fab'd. Metal Products (SIC 34)	Ordn. (SIC 19)	Radio, TV, Comm., Engr., & Elect. (SIC 365 -367)	Aircraft & Parts (SIC 372)	Other Engr. Products (SIC 35, 38, excl. col.5&6)	Chem. & Related Parts (SIC 28)	Trans. & Comm.	All Other Supplies of Parts & Serv.	All Supplies Number	Total Number Direct Employment	Number	% of Prod. Workers
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
All Employees	846,600	154.45	41,569	40,038	4,070	-	9,003	60,419	8,112	27,720	283,160	474,091	121.68	1,320,691	140.84
- Non-production employees	298,475	54.45	7,541	8,817	2,035	-	3,821	15,104	2,896	3,243	40,999	84,456	21.68	382,934	40.84
-- R&D (scientists, engineers and technicians)	86,100	16.07	269	377	666	-	923	2,191	594	10	522	5,552	1.43	93,652	9.99
-- Other technicol	76,400	13.94	1,439	1,558	605	-	649	4,160	746	440	2,631	12,228	3.14	88,628	9.45
-- Admin., sales, & clerical	133,975	24.44	5,833	8,440	764	-	2,249	8,753	1,556	2,793	37,846	68,234	17.51	202,209	21.56
- Production workers, total	548,125	100.00	35,028	31,220	2,035	-	5,156	45,309	5,216	24,477	242,161	389,602	100.00	937,727	100.00
-- Foundry patterns	-	-	207	64	2	-	15	206	-	-	-	494	0.13	494	0.05
-- Ferrous foundry	-	-	5,787	470	1	-	3	651	-	-	-	6,912	1.77	6,912	0.74
-- Non-ferrous foundry	612	0.11	1,805	406	3	-	6	209	-	-	-	2,429	0.62	3,041	0.32
-- Tool and die making	9,350	1.71	238	905	105	-	221	2,101	-	-	-	3,570	0.92	12,920	1.38
-- Forging, pressing, upsetting	-	-	890	175	5	-	19	172	-	-	-	1,261	0.32	1,261	0.13
-- Ports fabrication of steel	2,525	0.46	92	3,563	135	-	159	1,622	-	-	-	5,571	1.43	8,096	0.86
-- Stamping	11,142	2.03	392	6,806	72	-	146	3,024	-	-	-	10,440	2.68	21,582	2.30
-- Plastics molding	3,837	0.70	-	-	16	-	45	131	-	-	-	192	0.05	4,029	0.43
-- Heat treatment	1,185	0.22	330	237	12	-	28	343	-	-	-	950	0.24	2,135	0.23
-- Ploting and galvanizing	4,348	0.79	200	2,500	24	-	25	281	-	-	-	3,030	0.78	7,378	0.79
-- Automatic screw machine d-t	2,909	0.53	23	1,356	21	-	15	512	-	-	-	1,927	0.49	4,836	0.52
-- Machining	33,710	6.15	1,214	2,923	209	-	854	8,681	-	-	-	13,881	3.56	47,591	5.08
-- Painting, lacquering, etc.	3,230	0.59	-	996	33	-	57	1,237	-	-	-	2,323	0.60	5,553	0.59
-- Assembly of products	343,617	62.69	-	2,035	370	-	942	14,909	-	-	-	18,256	4.69	361,873	38.59
-- All other operations	131,660	24.02	22,850	8,784	1,029	-	2,619	11,229	5,216	24,477	242,161	318,365	81.72	450,025	47.99

Source: Census of Manufacturers, Bureau of Labor Statistics, National Science Foundation.

Table D-22

TOTAL LABOR REQUIREMENTS IN PRODUCTION OF MOTOR VEHICLES AND EQUIPMENT (SIC 371)
BY TYPE OF WORK (OPERATION), 1963

Value of output (Net) $12,055 million Type of Work	Intramural (Industry's) Employment	% of Prod. Workers	Total (Direct and Indirect) Employment Associated with Supplies from Industry:										Approximate Total Employment (Direct and Indirect)	
			Primary Metals (SIC 33)	Fab'd. Metal Products (SIC 34)	Ordn. (SIC 19)	Radio, TV, Comm., Engr., & Elect. (SIC 365 -367)	Aircraft & Parts (SIC 372)	Other Engr. Products (SIC 35, 38, excl. col. 5&6)	Chem. & Related Parts (SIC 28)	Trans. & Comm.	All Other Supp'r of Parts & Serv.	All Supplies Number	Total Number Direct Employment	Number	% of Prod. Workers
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
All Employees	693,821	121.50	226,659	147,491	1,017	11,344			16,518	87,840	578,652	1,179,461	121.57	1,873,282	121.42
- Non-production employees	122,795	21.50	41,120	32,481	509	4,000			5,897	10,277	83,782	207,649	21.37	330,444	21.42
-- R&D (scientists, engineers and technicians)	31,500	5.52	1,469	1,390	166	1,181			1,210	32	1,067	10,241	1.05	41,741	2.71
-- Other technical	20,200	3.54	7,847	5,738	151	1,024			1,519	1,396	5,377	31,763	3.27	51,963	3.37
-- Admin., soles, & clericol	71,095	12.45	31,805	31,090	191	1,795			3,169	8,850	77,337	171,383	17.64	242,478	15.72
- Production workers, total	571,026	100.00	185,539	115,009	509	7,345			10,621	77,563	494,850	971,812	100.00	1,542,838	100.00
-- Foundry patterns	896	0.16	1,131	236	-	-			-	-	-	1,802	0.19	2,698	0.17
-- Ferrous foundry	8,022	1.40	31,552	1,730	-	-			-	-	-	34,445	3.54	42,467	2.75
-- Non-ferrous foundry	1,433	0.25	9,844	1,497	1	-			-	-	-	11,770	1.21	13,203	0.86
-- Tool and die making	27,241	4.77	1,298	3,334	26	125			-	-	-	8,479	0.87	35,720	2.32
-- Forging, pressing, upsetting	4,107	0.72	4,851	645	1	-			-	-	-	5,723	0.59	9,830	0.64
-- Ports fabrication of steel	5,384	0.94	503	13,125	34	34			-	-	-	17,195	1.77	22,579	1.46
-- Stamping	69,857	12.23	2,136	25,073	18	149			-	-	-	31,430	3.23	101,287	6.56
-- Plastics molding	670	0.12	-	-	4	51			-	-	-	329	0.33	999	0.06
-- Heat treatment	4,540	0.80	1,801	873	3	16			-	-	-	3,292	0.34	7,832	0.51
-- Plating and galvanizing	4,045	0.71	1,089	9,210	6	58			-	-	-	10,840	1.12	14,885	0.96
-- Automatic screw machine d-t	3,677	0.64	125	4,996	5	39			-	-	-	6,185	0.64	9,865	0.64
-- Machining	76,028	13.31	6,617	10,767	52	452			-	-	-	34,666	3.57	110,694	7.17
-- Painting, lacquering, etc.	26,610	4.66	-	3,668	8	43			-	-	-	5,457	0.56	32,067	2.08
-- Assembly of products	296,997	52.01	-	7,497	93	4,604			-	-	-	34,136	3.51	331,133	21.46
-- All other operations	41,519	7.27	124,598	32,359	257	1,764			10,621	77,563	494,850	766,058	78.83	807,577	52.34

Source: Census of Manufacturers, Bureau of Labor Statistics, National Science Foundation.

Table D-23

LABOR REQUIREMENTS PER ONE BILLION DOLLARS (REAL 1963 PRICE = 100)
OF DOD PROCUREMENT

	Motor Vehicles and Parts (SIC 371)					
	1963			1970		
Type of Work	Direct[b] Employees %	Indirect[c] Employees %	Total Employees %	Direct Employees %	Indirect Employees %	Total Employees %
All Employees	100	100	100	100	100	100
Non-production workers	18	18	18	19	20	20
R&D	4	1	2	6	1	3
Other technical	3	3	3	5	3	3
Adm., sales, clerical	10	14	13	8	17	14
Production workers	82	82	82	81	80	80
Machining	11	3	6	11	3	6
Assembly	43	3	18	30	3	24
Others[a]	6	65	43	8	63	41
Total Employment (number)	25,826	43,903	69,729	26,559	39,672	66,231
Percentage of Direct Total Employees	100	170	270	100	149	249

NOTES: a) Includes maintenance, shipping, inventory, warehousing, quality control, etc. Excludes foundry, stamping, painting, etc. See Tables D-17 through D-22 for complete breakdown of labor categories.

b) Employed in the industry.

c) Employed in all other supplying industries producing input materials.

Table D-24

LABOR REQUIREMENTS PER ONE BILLION DOLLARS (REAL 1963 PRICE = 100)
OF DOD PROCUREMENT

	Aircraft and Parts (SIC 372)					
	1963			1970		
Type of Work	Direct[b] Employees %	Indirect[c] Employees %	Total Employees %	Direct Employees %	Indirect Employees %	Total Employees %
All Employees	100	100	100	100	100	100
Non-production workers	43	20	34	44	23	35
R&D	10	2	7	10	2	7
Other technical	7	4	6	9	4	7
Adm., sales, clerical	25	14	21	25	17	21
Production workers	57	80	66	56	77	65
Machining	9	4	7	16	4	11
Assembly	10	9	10	8	9	9
Others[a]	29	57	40	24	56	37
Total Employment (number)	55,987	36,049	92,036	44,789	32,105	76,894
Percentage of Direct Total Employees	100	64	164	100	71	171

NOTES: a) Includes maintenance, shipping, inventory, warehousing, quality control, etc. Excludes foundry, stamping, painting, etc. See Tables D-17 through D-22 for complete breakdown of labor categories.
b) Employed in the industry.
c) Employed in all other supplying industries producing input materials.

Table D-25

LABOR REQUIREMENTS PER ONE BILLION DOLLARS (REAL 1963 PRICE = 100) OF DOD PROCUREMENT

	Radio, T.V., Communication, Electronic Equipment (SIC 365-367)					
	1963			1970		
Type of Work	Direct[b] Employees %	Indirect[c] Employees %	Total Employees %	Direct Employees %	Indirect Employees %	Total Employees %
All Employees	100	100	100	100	100	100
Non-production workers	35	18	29	39	21	32
R&D	10	1	7	9	1	6
Other technical	9	3	7	9	3	7
Adm., sales, clerical	16	14	15	21	17	19
Production workers	65	82	71	61	79	68
Machining	4	3	4	3	3	3
Assembly	40	4	27	42	4	26
Others[a]	16	67	34	13	65	34
Total Employment (number)	61,526	34,454	95,980	44,373	31,105	75,478
Percentage of Direct Total Employees	100	56	156	100	70	170

NOTES: a) Includes maintenance, shipping, inventory, warehousing, quality control, etc. Excludes foundry, stamping, painting, etc. See Tables D-17 through D-22 for complete breakdown of labor categories.

b) Employed in the industry.

c) Employed in all other supplying industries producing input materials.

Table D-26

PERCENTAGE DISTRIBUTION OF EMPLOYEES (16 YEARS OR OLDER) BY JOB CATEGORIES IN DIFFERENT SIC INDUSTRIES

Job Categories	Fabricated metal 34	Machinery except electrical 35	Electrical machinery 36	Motor vehicles & equip. 371	Aircraft & parts 372	Other trans-portation 373-379	Ordnance 19	Total Mfg. operations
Professional, technical and kindred workers	7.2	13.7	18.5	8.1	26.2	8.7	27.1	10.0
Managers, administrators	6.1	6.2	5.2	2.6	4.6	4.2	5.0	5.2
Sales workers	2.0	2.4	1.3	0.8	0.4	0.9	0.4	2.7
Clerical	12.2	13.6	13.6	9.8	15.6	9.6	15.0	12.6
Craftsmen	23.4	23.5	14.5	22.5	24.0	41.1	16.6	19.6
Operatives except transport	40.6	35.3	42.3	46.5	25.6	26.8	28.4	40.0
Transport operatives	2.5	1.4	0.9	3.1	0.7	2.1	1.7	3.1
Laborers	4.1	2.1	1.9	3.7	1.0	4.4	2.9	4.6
Service workers	1.9	1.8	1.8	2.9	1.9	2.2	2.9	2.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Census of Population 1970: Occupation by Industry, Department of Commerce, Table 1

Data is based on 5% sample.

Table D-27

DIRECT AND INDIRECT MATERIAL REQUIREMENTS FOR ONE DOLLAR OF FINAL PROCUREMENTS OF DOD-RELATED INDUSTRIES: 1966

From / To SIC	Ordnance SIC 19	Aircraft & Parts SIC 372	Radio, TV Equip. SIC 365-366	Electronic Components SIC 367
19	1.03	0.02	0.01	0.01
372	0.29	1.19	0.02	0.01
365-366	0.07	0.06	1.09	0.07
367	0.04	0.03	0.22	1.11
Subtotal	1.43	1.30	1.34	1.20
Total Input	2.19	2.13	2.55	2.25
Percentage of Inputs Emanating from DOD-Related Industries Inputs	65%	61%	52%	53%

Source: Input-Output Transactions, Bureau of Economic Analysis, 1966, Department of Commerce, February 1972.

NOTE: The material requirements are expressed in dollars and represent the inputs required from all industries to produce a dollar of final goods in that particular industry. (These figures include multiple county and intermediate transactions.)

Table D-28

VALUE OF MANUFACTURING INVENTORIES FOR DOD-RELATED INDUSTRIES (1967)
($ Million)

SIC	Industry	Value of Inventory Total	Finished Goods	Work in Process	Materials	Ratio of Inventory to Shipments
19	Ordnance	1,314	166	775	373	.142
1925	Guided Missiles	485	7	405	73	.105
34	Fabricated Metal Products	5,655	1,509	1,969	2,177	.164
35	Machinery (not elect.)	10,917	3,073	5,047	2,797	.225
36	Electrical Equip. & Supplies	8,526	2,041	4,119	2,366	.197
365	Radio & TV Equip.	755	316	199	250	.186
366	Communication Equip.	2,651	221	1,928	502	.238
367	Elect. Components	1,286	243	643	400	.173
37	Transportation	12,326	1,188	8,066	3,072	.180
371	Motor Vehicle	3,527	635	1,524	1,368	.087
372	Aircraft & Parts	7,277	386	5,473	1,418	.345
373	Ships & Boat Building	916	46	761	109	.296
	All Manufacturing	84,405	26,772	29,107	28,526	.151

Source: (1) Annual Survey of Manufacturers: 1970, Department of Commerce, June 1972.
(2) Shipments to Defense-Oriented Industries: 1967, Department of Commerce, August 1969.

Table D-29

RATIOS OF INVENTORY TO SHIPMENTS SELECTED INDUSTRIES 1967-1970

SIC	INDUSTRY	1967	1968	1969	1970	% CHANGE 1967-1970
19	ORDNANCE	.142	.157	.129	.129	-9%
1925	GUIDED MISSILES	.105	.118	.106	.099	-6%
34	FABRICATED METAL PRODUCTS	.164	.165	.165	.169	3%
35	MACHINERY (NOT ELECT.)	.225	.226	.237	.252	12%
36	ELECTRICAL EQUIP. & SUPPLIES	.197	.192	.200	.208	6%
365	RADIO & TV EQUIP.	.186	.153	.176	.180	-3%
366	COMMUNICATION EQUIP.	.238	.240	.239	.224	-6%
367	ELEC. COMPONENTS	.173	.175	.193	.224	29%
37	TRANSPORTATION	.180	.177	.173	.208	15%
371	MOTOR VEHICLE	.077	.079	.080	.099	14%
372	AIRCRAFT & PARTS	.345	.374	.377	.452	31%
373	SHIPS & BOAT BUILDING	.296	.306	.270	.246	-17%
	ALL MANUFACTURING	.151	.150	.150	.160	6%

Table D-30

TRENDS IN U.S. MERCHANDISE TRADE
TOTAL AND "ENGINEERING" PRODUCTS[b], 1960-1972

	1960	1965	1970	1971	1972	Ave. Annual Growth Rate in 1960-72 % Compounded
1. Total merchandise trade:						
Exports[a]	20,608	27,530	43,224	44,130	49,768	7.6
Imports	15,073	21,429	39,952	45,563	55,555	11.5
Balance	5,535	6,101	3,272	-1,433	-5,787	-
2. "Engineering" Products[b]						
Exports[a]	7,719	11,152	19,421	21,060	23,114	9.6
Imports	1,550	3,116	11,573	14,316	17,939	22.7
Balance	6,169	8,036	7,848	6,744	5,175	-
2A. "Engineering" Products Manufactured Largely with Discrete Processes[c]						
Exports[a]	5,984	8,933	14,653	15,717	16,793	9.0
Imports	750	1,674	4,275	4,712	6,260	19.3
Balance	5,234	7,259	10,378	11,005	10,533	-
2B. "Engineering" Products Manufactured Largely with Continuous Processes						
Exports[a]	1,735	2,219	4,768	5,343	6,321	11.4
Imports	800	1,442	7,298	9,604	11,319	25.0
Balance	935	777	-2,530	-4,261	-4,998	-

[a] Data on U.S. exports include "non-commercial" shipments, such as military grant/aid and shipments of agricultural commodities under Public Law 480.

[b] Products of industries SIC 35 (non-elect. machinery), SIC 36 (elect. machinery & equip.), SIC 37 (transportation equip.), SIC 38 (instruments and controls), and SIC 39 (ordnance).

[c] Total of engineering products less the sum of automobiles and equipment. Household appliances; radios, TV, and other telecommunications equipment; and phonographic and sound reproduction equipment.

Source: U.S. Department of Commerce.

(Continued)

Analytical Note to Table D-30:

Engineering products 2A is one of two and by far the most important commodity group (the other -- chemicals, but much less important) that has consistently yielded trade surpluses and maintained external value of the dollar. The growth of imports of these products, more than twice as rapid as that of exports, implies that even here we are losing the advantage. Programmable Automation would help to counter this trend.

APPENDIX E:

HUGHES AIRCRAFT TOW MISSILE PRODUCTION - SUPPLEMENTARY DATA

AN ESTIMATE OF THE MANUFACTURING COSTS, PLANT INVESTMENT AND OPEN PRODUCTIVE CAPACITY FOR A FLEXIBLY AUTOMATED FACTORY, CAPABLE OF PRODUCING TOW MISSILES AND/OR OTHER ELECTRO-MECHANICAL PRODUCTS

SPECTRAVISION
1/27/73

ESTIMATE OF MANUFACTURING COST AND FACILITY
(TOW MISSILES ONLY)

MAJOR ASSUMPTIONS:

1. TOW'S PRODUCED AT A RATE OF 600/MONTH (AVERAGE)
2. PLANT OPERATES 300 DAYS/YEAR, 24 HOURS/DAY
3. DOWNTIME IS 65 DAYS/YEAR, 24 HOURS/DAY, CONSISTING OF:
   A. SCHEDULED DOWNTIME OF 18 DAYS/YEAR, 8 HOURS/DAY
   B. UNSCHEDULED DOWNTIME OF 18 DAYS/YEAR, 8 HOURS/DAY
   C. IDLE TIME OF 29 DAYS/YEAR, 24 HOURS/DAY
      PLUS 36 DAYS/YEAR, 16 HOURS/DAY
4. ALL PURCHASED ITEMS ARE SOURCE INSPECTED PRIOR TO SHIPMENT
5. THE TOW PRODUCTION PROCESS IS AS PER FLOW SHEETS (A THROUGH H PLUS SUMMARY SHEET) APPENDED.
6. SPARE CAPACITY IS THAT MACHINE CAPACITY NOT REQUIRED BY TOW.

CAPITAL INVESTMENT, DEPRECIATION AND OPEN CAPACITY

		Minutes/ Missiles	Machines Required	Machines Purchased	Open Capacity	Purchase $ Instaltn.	Annual Deprcsn.	Depreciation Method	Allocated to Tow	Allocated to Open Cap.
1.	Machining Center	210.0	3.50	4	.50	$2,640,000.	$198,000.	A	$173,000.	$25,000.
2.	Precsn Load/Unld 1.	60.0*	1.0	1	--	66,000.	5,940.	B	5,940.	--
3.	Grinding Machine	10.0	.17	1	.83	106,500.	8,000.	A	1,360.	6,640.
4.	Coil Winding Machine	0.6	.01	1	.99	16,000.	1,440.	B	15.	1,425.
5.	Wire Wrap Machine	10.4	.17	1	.83	100,000.	9,000.	B	1,530.	7,470.
6.	Board Stuffing Mach	2.0	.03	1	.97	22,200.	1,998.	B	60.	1,938.
7.	Precsn Ld/Unld 3,4, 5,6	17.0*	.28	1	.72	66,000.	5,940.	B	1,640.	4,300.
8.	Wave Solder & Deflux	5.0	.09	1	.91	36,700.	3,303.	B	300.	3,303.
9.	Chemical Finishing	2.0	.03	1	.97	66,000.	5,940.	B	178.	5,762.
10.	Chemical Cleaning	4.6	.08	1	.92	66,000.	5,948.	B	475.	5,465.
11.	Painting	1.0	.01	1	.99	26,700.	3,004.	C	30.	2,974.
12.	Potting	2.0	.03	1	.97	12,000.	1,350.	C	41.	1,309.
13.	Dimensional & Finish Tests	25.0	.42	1	.58	220,000.	23,750.	C	9,975.	13,775.
14.	Environmental and Electronic Tests	30.0	.50	1	.50	64,000.	5,760.	B	2,880.	2,880.
15.	Prcsn Load/Unld 13&14	30.0*	.50	1	.50	66,000.	5,940.	B	2,970.	2,970.
16.	Assembly Machine (Mech. Assy)	43.5								
17.	Control Assy Test (in Assy Mach.)	1.0	.80	1	.20	667,000.	60,030.	B	48,024.	12,006.
18.	Assembly Machine (Electric Tests)	2.3								
19.	Assy. Machine (Base Layer Inspectn).	1.0								
20.	Electric Test Unit	2.3	.80*	1	.20	20,000.	2,250.	C	1,800.	450.
21.	Prcsn Load/Unld 16,17, 18	47.8*	.80	1	.20	66,000.	5,940.	B	4,752.	1,188.

*Time dictated by associated equipment rather than by flow-chart data.

		Minutes/ Missiles	Machines Required	Machines Purchased	Open Capacity	Purchase $ Instaltn.	Annual Deprcsn.	Depreciation Method	Allocated to Tow	Allocated to Open Cap.
12.	Programmable Fixtures and Pallets	.5 System		1 System	.50 System	$1,000,000.	$112,500.	C	$ 56,250.	$56,250.
13.	Conveyor and Storage	.5 System		1 System	.50 System	330,000.	29,700.	B	14,850.	14,850.
14.	Receiving Equipment	20.9	.35	1 Set	.65 Set	66,700.	6,003.	B	2,100.	3,903.
15.	Scrap Removal Eqpt.	.25 System		1 System	.75 System	800,000.	60,000.	A	15,000.	45,000.
16.	Computer & Terminals	.25 System		1 System	.75 System	4,000,000.	300,000.	A	75,000.	225,000.
17.	Office Equipment	60.0	1 Set	1 Set	--	70,000.	5,250.	A	5,250.	--
	Subtotal I					8,193,800.	866,978.		423,420.	443,558.
	+ 20% for oversights					1,638,760.	173,396.		84,684.	88,712.
	Subtotal II					9,832,560.	1,040,374.		508,104.	532,270.
	Annual depreciation with 60% government ownership						416,150.		203,242.	212,908.
	Real Property - 100% government owned D					--	--		--	--
	Real Property - 100% privately owned D					1,400,000.	26,667.		13,334.	13,334.
	Total investment					11,232,560.				
	Annual depreciation total (60% government owned)						416,150.		203,242.	212,908.
	Annual depreciation total (100% privately owned)						1,067,041.		521,438.	745,178.

A - 12 year straight line, 10% remainder
B - 10 year straight line, 10% remainder
C - 8 year straight line, 10% remainder
D - 40,000 sq. ft. building @ $30/sq. ft.; 45 year straight line; 10% remainder
4 acres land @ $50,000/acre; no depreciation

E5

ESTIMATED OPERATING COSTS FOR TOW PRODUCTION

Overhead	60% Gov't Owned	Privately Owned
Receiving and conveyor loading labor (A)	$ 12,540.	
Programmer/planners (B)	300,000.	
Maintenance and repair labor (C)	184,079.	
Purchasing/source inspection (D)	102,000.	
Production control (E)	58,000.	
Receptionists/guards (F)	100,000.	
Custodians (G)	6,656.	
Total OH labor (annual)	$763,275.	
Fringe benefits @ 30% of labor	228,983.	
Maintenance and repair materials	400,000.	
Other supplies (office, computer, shop)	100,000.	
Utilities	30,000.	
Depreciation	$203,242.	$745,175.
Insurance	65,000.	110,000.
Miscellaneous	50,000.	
Total on Cost (annual)	$1,840,500.	$2,427,433.

G&A	
General Manager	$ 40,000.
Financial Executive	32,000.
Accountant	20,000.
2 Secretaries	36,000.
Total Labor	128,000.
Fringe benefits @ 30%	38,400.
Corporate G&A Allocated	120,000.
Miscellaneous	30,000.
Total G&A Cost (annual)	$316,400.

MATERIAL AND SUBCONTRACTS	
With conventional vendors (H)	$14,400,000.
With automated vendors (I)	$ 8,640,000.

A - From flow-charts - 20.9 min/unit x 7200 units x $5/hr
B - 20 men for 8 hrs/day @ $15,000/yr each
C - 12-man maintenance crew, 9 days/yr; 24 hr/day, $7.65/hr = $19,829/yr
4-man repair crew, 365 days/yr; 24 hrs/day, $8.50/hr = $164,250/yr
D - 4 purchasing agents @ $12,500/yr, 2 source inspectors @ $18,000/yr, 2 secretaries @ $8,000/yr
E - 2 managers @ $22,000/yr, 2 secretaries @ $7,000/yr
F - 3/8 hr shift, plus 3/yr replacement @ $10,000/yr/man
G - 4 men, 8 hrs/day, 52 days/yr, $4/hr
H - $2,000./missile
I - $1,200./missile

SUMMARY RESULTS

COSTS ADDED

	Annually (7200 Tows)	Per Tow
Private Ownership	$2,743,833	$381.
Gov't Owns Plant and 60% Eqpt.	$2,156,900	$300.

TOTAL MANUFACTURING COST/TOW

	Conventional Vendors	Automated Vendors
Private Ownership	$2,381.	$1,581.
Gov't Owns Plant and 60% Eqpt.	$2,300.	$1,500.

OPEN MACHINERY CAPACITY

See pages 2 and 3 for details

Approximately 51% of plant may be utilized for other than TOW production.

REPLACEMENT COST OF CURRENT FACTORY (A) $80,000,000

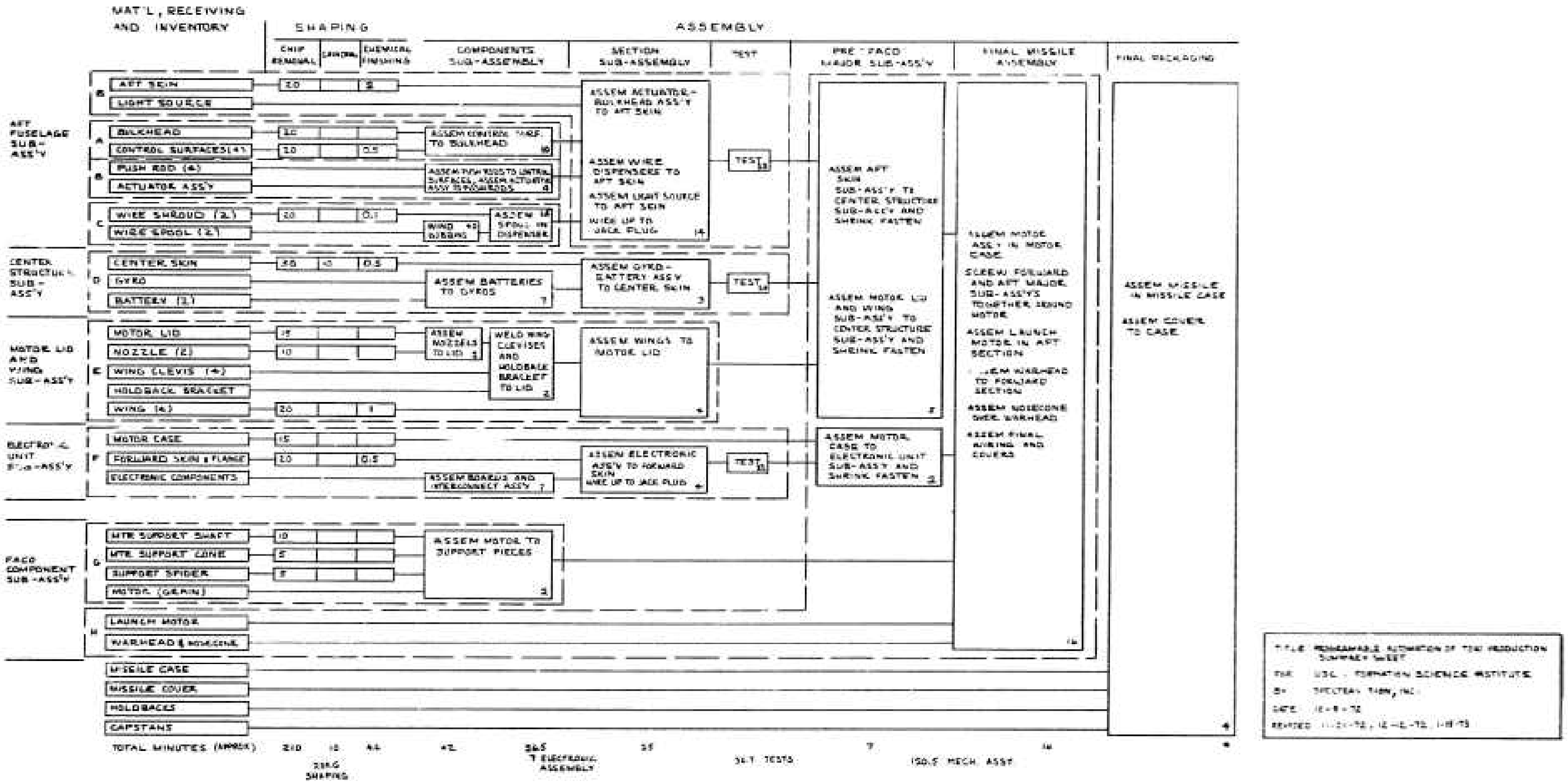
PRIVATE INVESTMENT IN PLANT AND EQUIPMENT

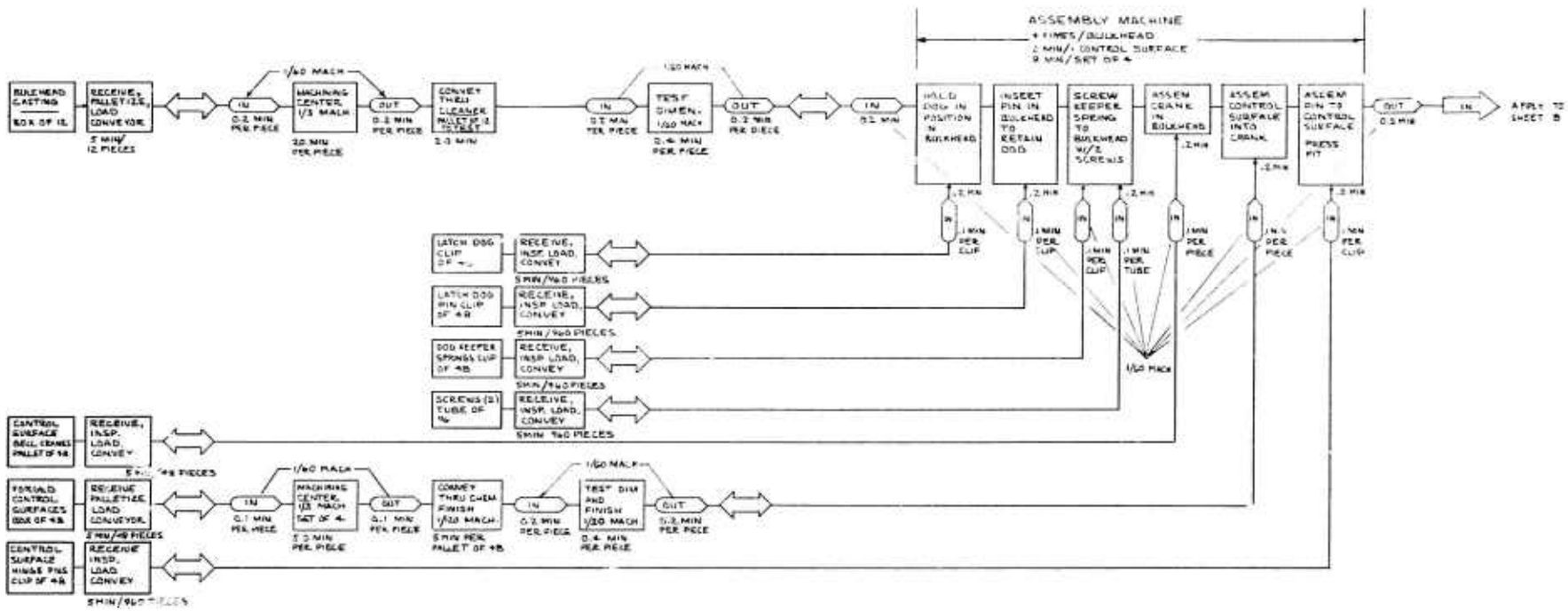
Current factory (B)
government owns plant and 60% equipment $26,600,000

Automated factory
government owns plant and 60% equipment $ 3,933,000

Automated factory
privately owned $11,232,560

A. - Estimated by an HAC Official
B. - 50 acres @ $50,000 allowed for land - $2,500,000.
$1,000,000 allowed for site improvements
400,000 sq. ft. building @ $25/ sq. ft. assumed = $10 000,000

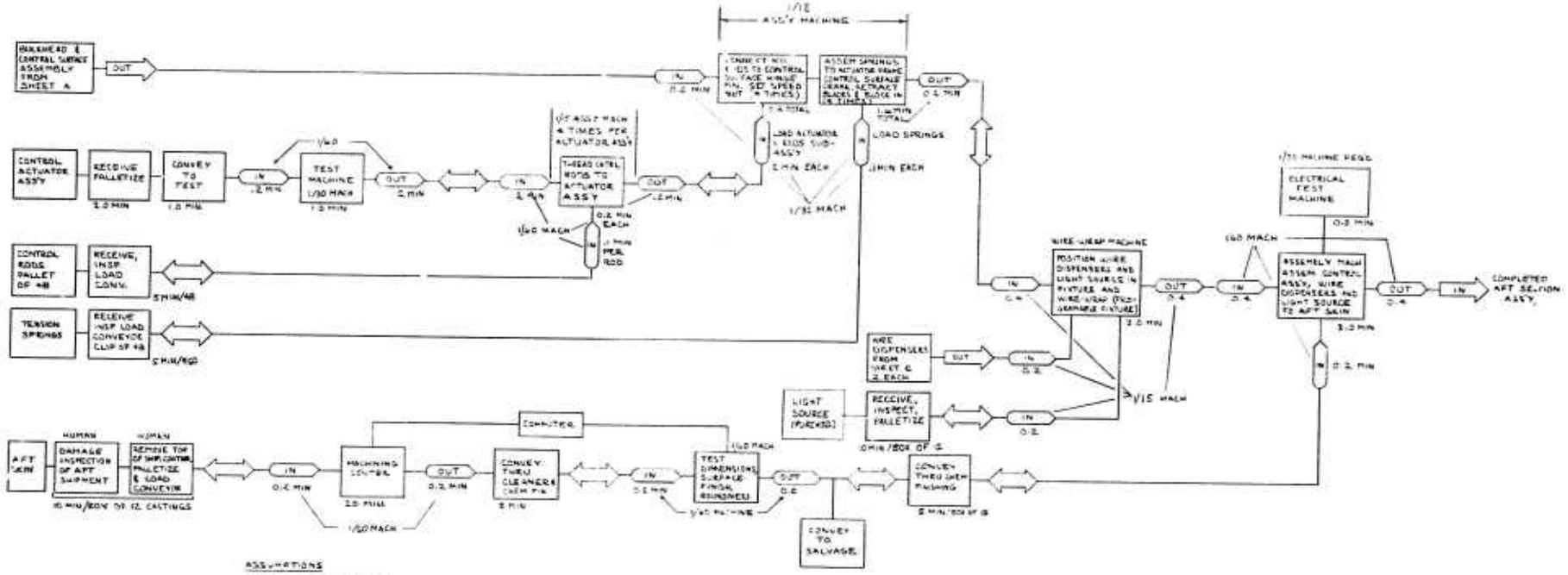

MAT'L, RECEIVING AND INVENTORY
SHAPING
CHIP REMOVAL
CHEMICAL FINISHING
ASSEMBLY
COMPONENTS SUB-ASSEMBLY
SECTION SUB-ASSEMBLY
TEST
PRE - FACO MAJOR SUB-ASS'Y
FINAL MISSILE ASSEMBLY
FINAL PACKAGING
AFT FUSELAGE SUB-ASS'Y
CENTER STRUCTURE SUB-ASS'Y
MOTOR LID AND WING SUB-ASS'Y
ELECTRONIC UNIT SUB-ASS'Y
FACO COMPONENT SUB-ASS'Y
AFT SKIN
LIGHT SOURCE
BULKHEAD
CONTROL SURFACES (4)
PUSH ROD (4)
ACTUATOR ASS'Y
WIRE SHROUD (2)
WIRE SPOOL (2)
CENTER SKIN
GYRO
BATTERY (2)
MOTOR LID
NOZZLE (2)
WING CLEVIS (4)
HOLDBACK BRACKET
WING (4)
MOTOR CASE
FORWARD SKIN & FLANGE
ELECTRONIC COMPONENTS
MTR SUPPORT SHAFT
MTR SUPPORT CONE
SUPPORT SPIDER
MOTOR (GRAIN)
LAUNCH MOTOR
WARHEAD & NOSECONE
MISSILE CASE
MISSILE COVER
HOLDBACKS
CAPSTANS
ASSEM CONTROL SURF. TO BULKHEAD
ASSEM BATTERIES TO GYROS
ASSEM MOTOR TO SUPPORT PIECES
ASSEM ACTUATOR-BULKHEAD ASS'Y TO AFT SKIN
ASSEM WIRE DISPENSERS TO AFT SKIN
ASSEM LIGHT SOURCE TO AFT SKIN
WIRE UP TO JACK PLUG
ASSEM GYRO-BATTERY ASS'Y TO CENTER SKIN
ASSEM WINGS TO MOTOR LID
ASSEM ELECTRONIC ASS'Y TO FORWARD SKIN
WIRE UP TO JACK PLUG
TEST
ASSEM AFT SKIN SUB-ASS'Y TO CENTER STRUCTURE SUB-ASS'Y AND SHRINK FASTEN
ASSEM MOTOR LID AND WING SUB-ASS'Y TO CENTER STRUCTURE SUB-ASS'Y AND SHRINK FASTEN
ASSEM MOTOR CASE TO ELECTRONIC UNIT SUB-ASS'Y AND SHRINK FASTEN
ASSEM MISSILE IN MISSILE CASE
ASSEM COVER TO CASE
TOTAL MINUTES (APPROX)
SHAPING
ELECTRONIC ASSEMBLY
SET TESTS
MECH. ASSY



ASSUMPTIONS

1 SAMPLE INSPECTION OF PURCHASED ITEMS
2 SHIPMENT SHOWS NO DAMAGE
3 600 UNITS PRODUCTION RATE/MONTH
4 ASSEMBLY MACHINES PER PRIOR DESCRIPTION
5 ⬭ = PRECISION MACHINE LOAD OR UNLOAD
⇨ = CONVEY IN OR OUT OF STORAGE (1.0 MIN)
⇔ = CONVEY IN AND OUT OF STORAGE (2.0 MIN)

TITLE: AFT BULKHEAD & CONTROL SURFACE ASSEMBLY (SHEET A)
FOR: USC INFORMATION SCIENCE INSTITUTE
BY: SPECTRAVISION, INC.
DATE: 10-9-72
REVISED: 11-21-72, 12-12-72; 1-11-73



ASSUMPTIONS

1, 2, 3, 4, 5, SEE SHEET A

6 TENSION SPRINGS REDESIGNED

7 CONTROL RODS REDESIGNED

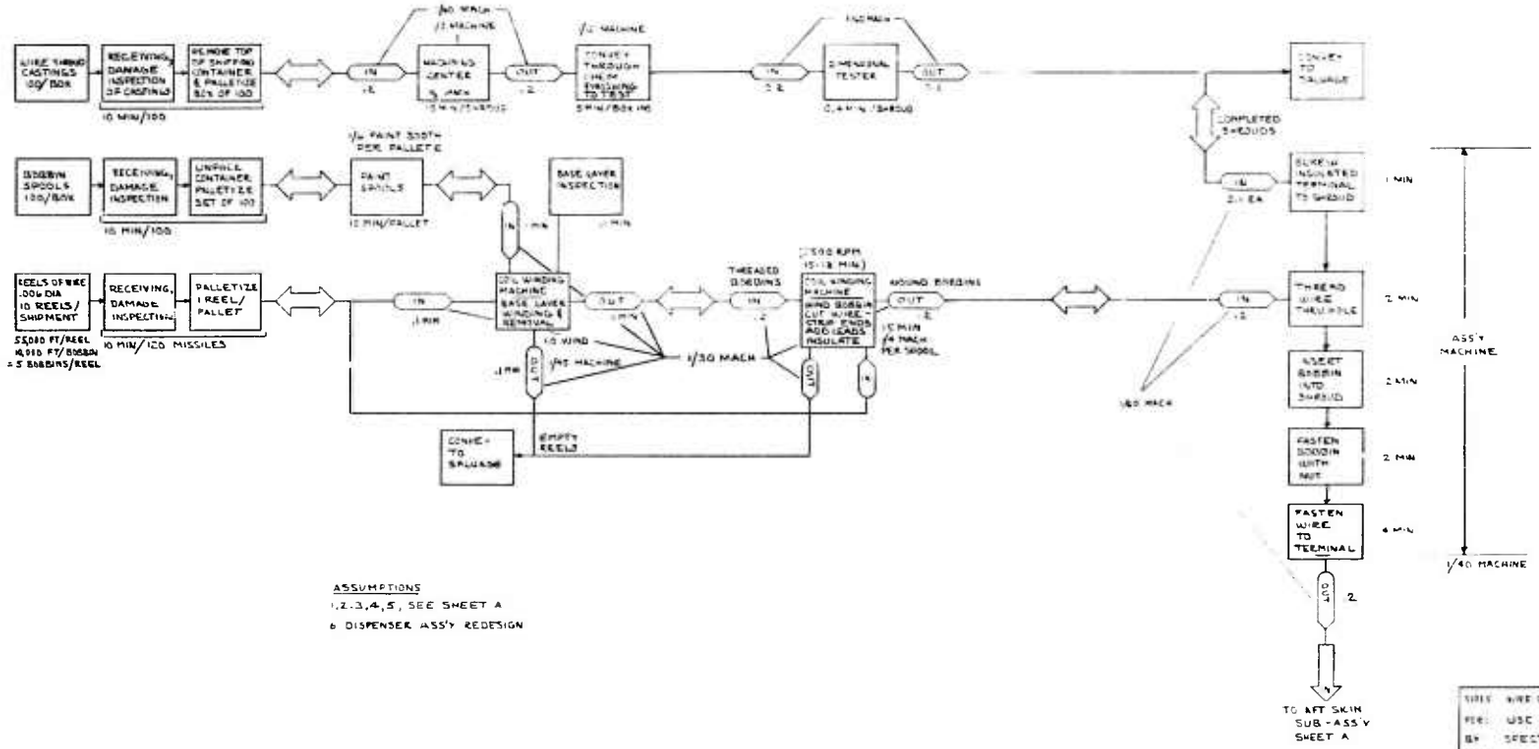
TITLE: AFT SECTION ASSY (SHEET B)

FOR: USC INFORMATION SCIENCE INSTITUTE

BY: SPECTRAVISION, INC.

DATE: 10-9-72

REVISED: 11-21-72; 12-12-72; 1-11-73

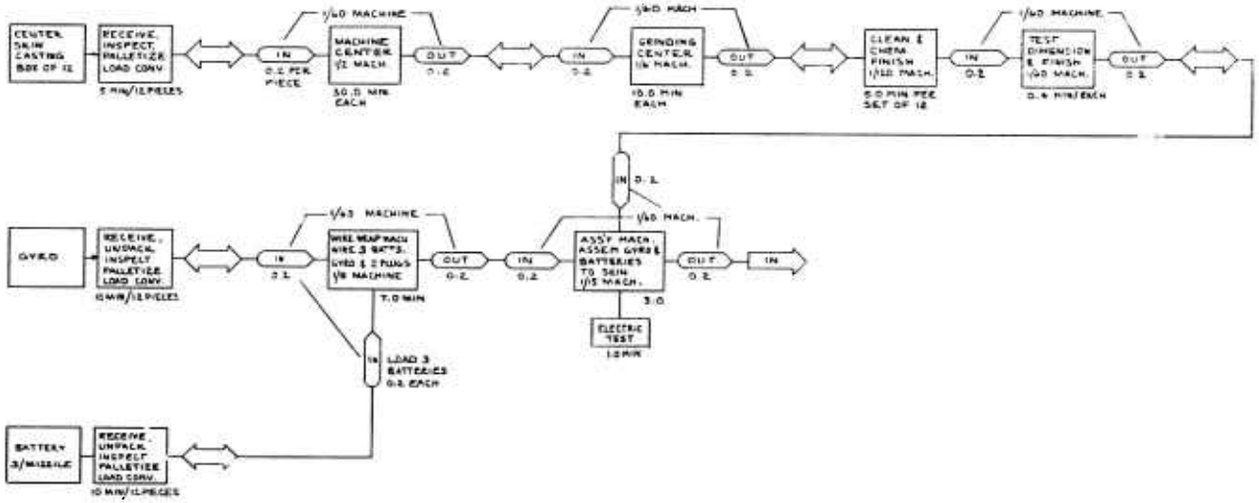


ASSUMPTIONS

1, 2, 3, 4, 5, SEE SHEET A

6 DISPENSER ASS'Y REDESIGN

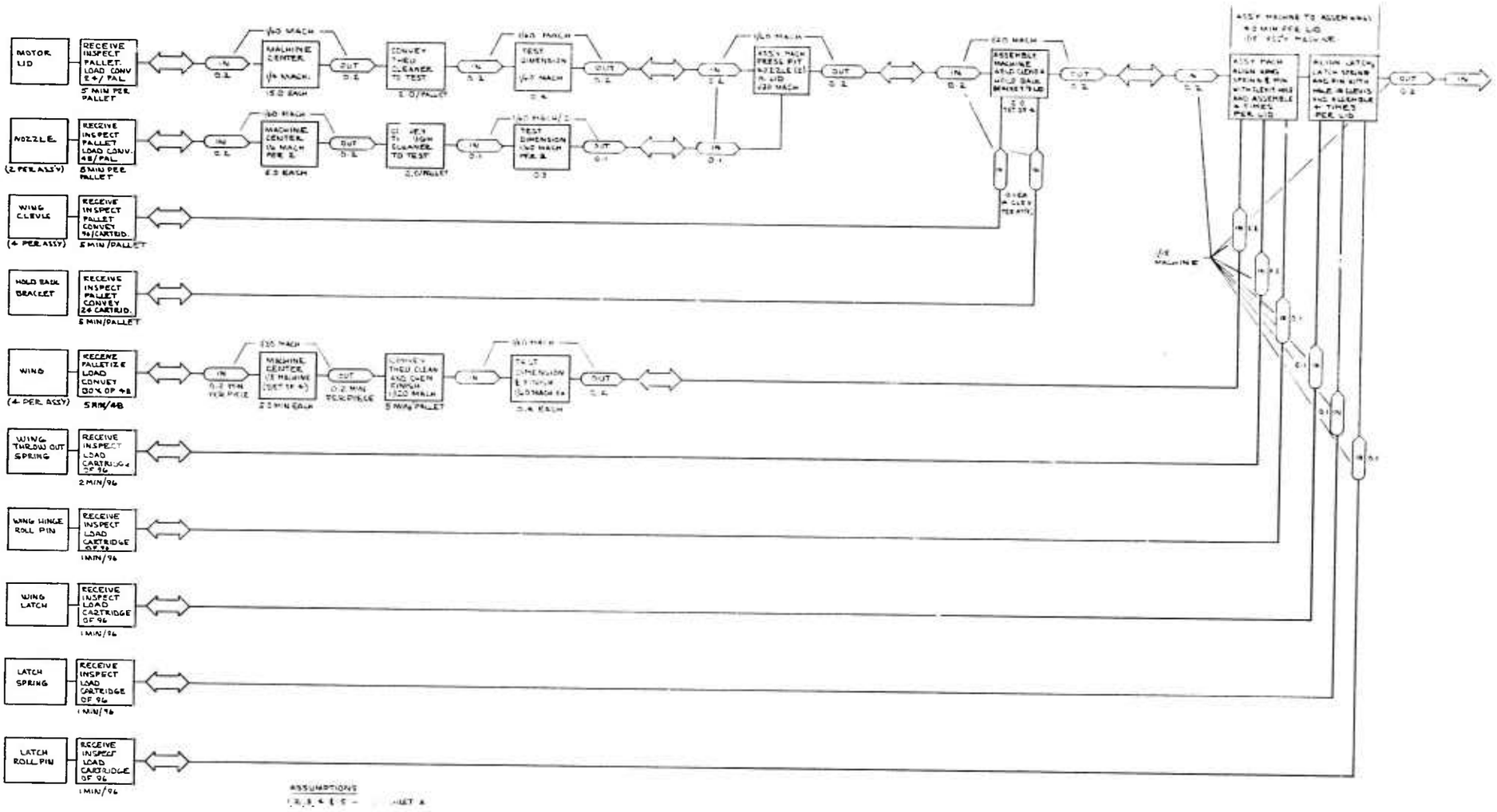
TITLE: WIRE DISPENSER ASSEMBLY (SHEET 6)
FOR: USC INFORMATION SCIENCE INSTITUTE
BY: SPECTRAVISION, INC.
DATE: 12-8-72
REVISED: 1-21-73; 12-12-73; 1-4-74



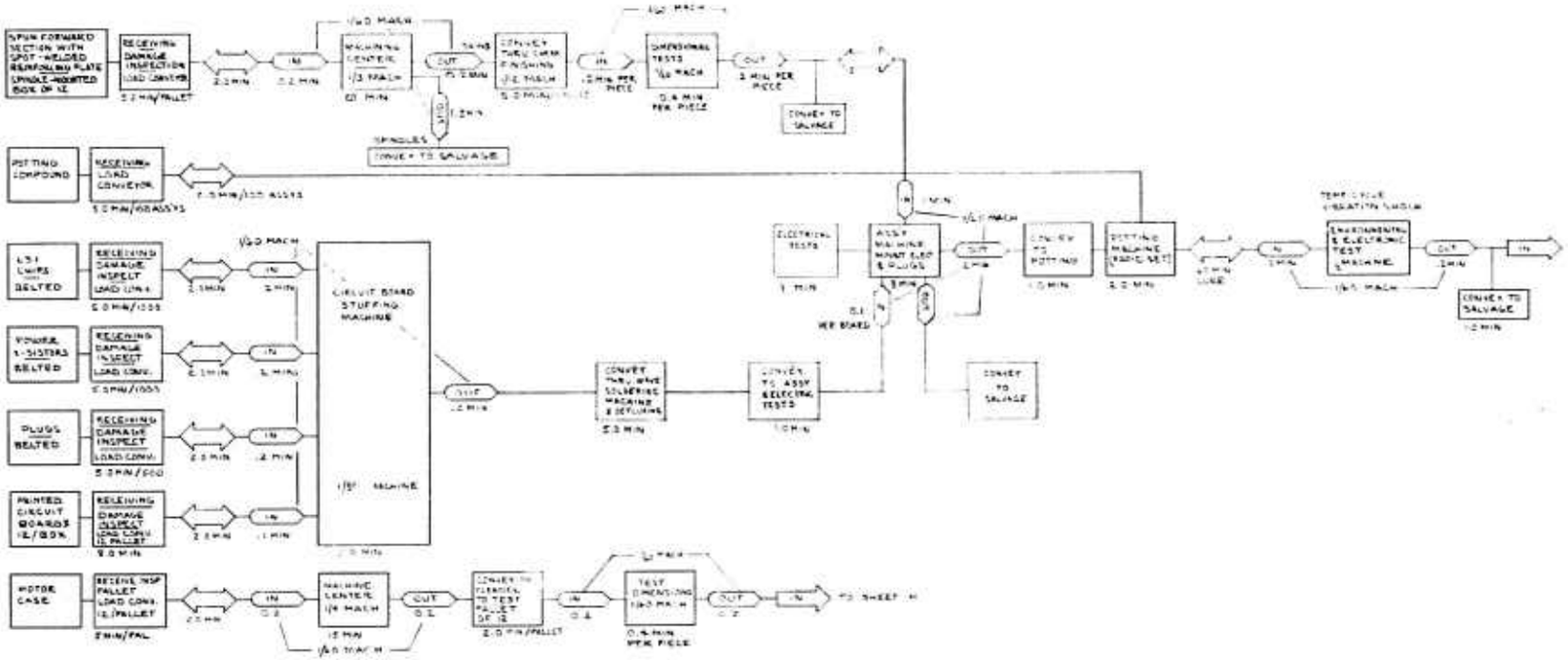
ASSUMPTIONS

1, 2, 3, 4 & 5 - SEE SHEET A

TITLE - CENTER SECTION (SHEET D)
FOR - USC INFORMATION SCIENCE INSTITUTE
BY - SPECTRAVISION, INC.
DATE - 10-9-72
REVISED - 11-21-72; 12-12-72; 1-11-73



TITLE: PROPULSION MOTOR LID AND WINGS (SHEET E)
FOR: USC INFORMATION SCIENCE INSTITUTE
BY: SPECTRAVISION, INC.
DATE: 10-9-72
REVISED 11-21-72; 12-12-72



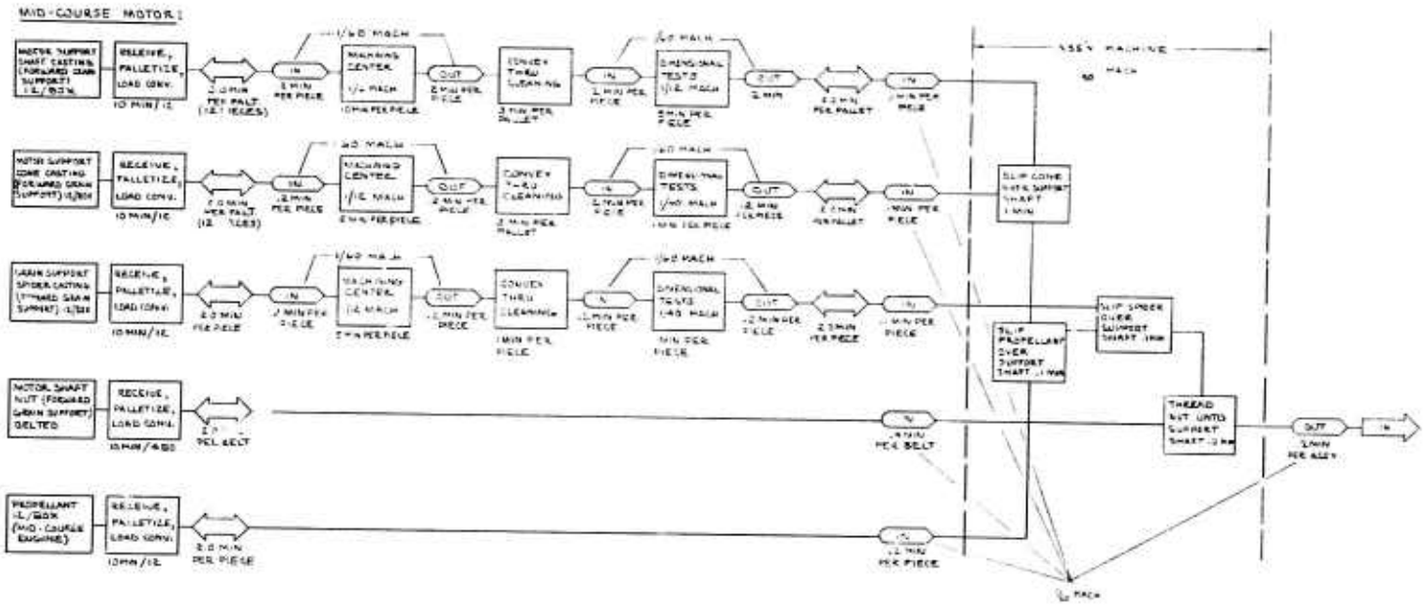
ASSUMPTIONS

1, 2, 3, 4, 5 - SEE SHEET A

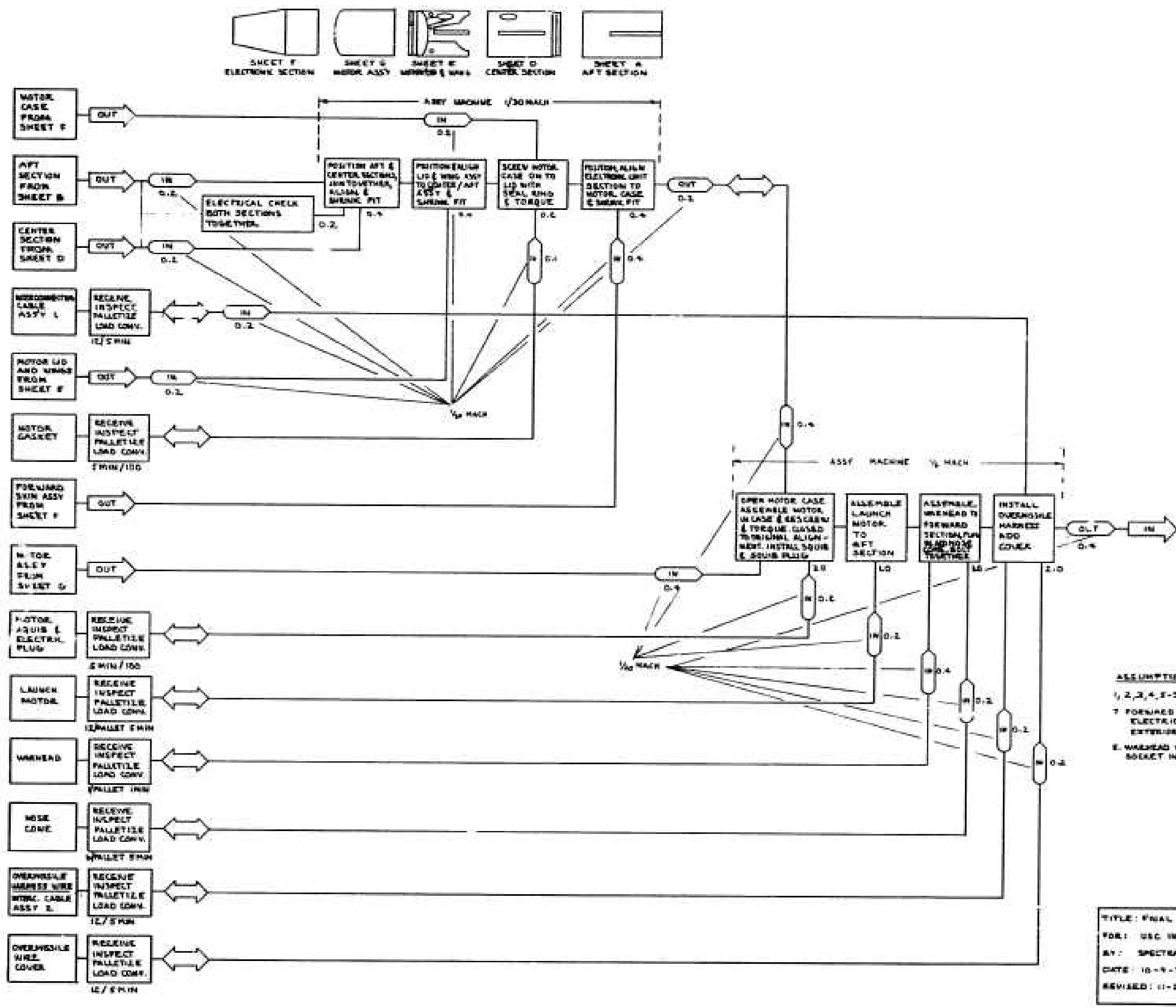
4 LSI CIRCUITS USED INSTEAD OF DISCRETE COMPONENTS
- LSI-CHIPS (50 TRANSISTORS, 20 DIODES)
- POWER OUTPUT (4 HIPWR TRANSISTORS)
- PLUGS

ONE BOARD/MISSILE

TITLE: FORWARD MAIN ASSY (ELECTRONIC UNIT & NOSE CASE) (SHEET F)
FOR: LSI OF NATION SCIENCE INSTITUTE
BY: SPECTRALISION, INC.
DATE: 10-9-72
REVISED: 11-21-72; 12-12-72; 1-11-73



TITLE:	MID-COURSE MOTOR ASSY. (SHEET 6)
FOR:	USC INFORMATION SCIENCE INSTITUTE
BY:	SPECTRAVISION, INC.
DATE:	6-5-72
REVISED:	11-21-72, 12-12-72, 1-11-73



ASSUMPTIONS

1, 2, 3, 4, 5 - SEE SHEET A

7 FORWARD CENTER & AFT SECTIONS ARE ELECTRICALLY INTERCONNECTED BY EXTERIOR FLEXIBLE PRINTED WIRING.

8. WARHEAD WIRES PLUG INTO 2-CONTACT SOCKET IN FORWARD SKIN ASSY.

TITLE: FINAL MISSILE ASSEMBLY SHEET H
FOR: USC INFORMATION SCIENCE INSTITUTE
BY: SPECTRAVISION, INC.
DATE: 10-9-72
REVISED: 11-21-72; 12-12-72; 1-8-73

APPENDIX F:

WESTERN GEAR CORPORATION - SUPPLEMENTARY DATA

1. Organization Chart, Manufacturing Department
   Precision Products Division

2. Gearbox, Engineering Parts List

3. Gearbox, Main Housing
   Manufacturing Order (MO)

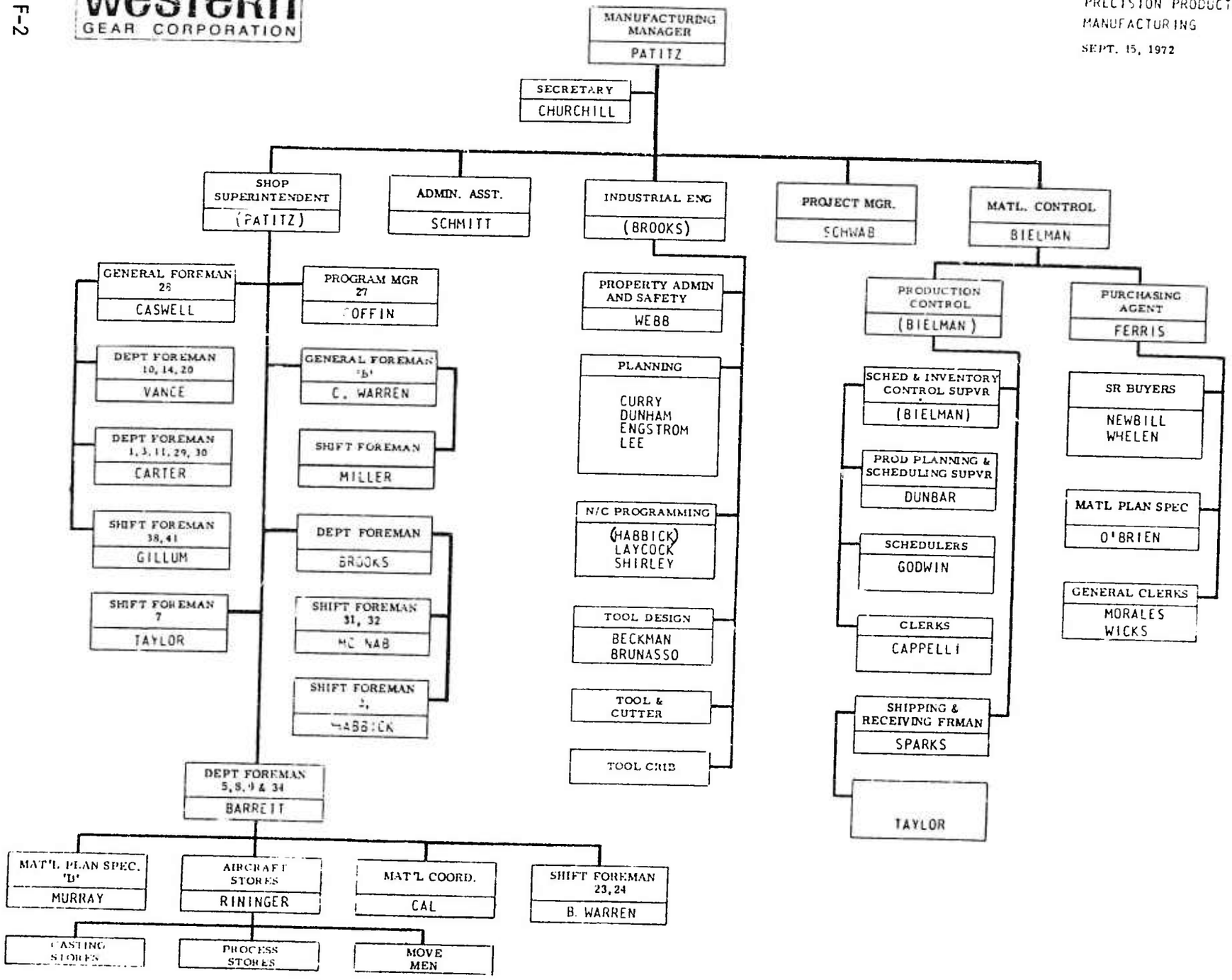
4. Gearbox, Assembly Inspection Record

F-2

Western GEAR CORPORATION

PRECISION PRODUCTS MANUFACTURING

SEPT. 15, 1972



CUSTOMER Lockheed Aircraft Corp.
SERIAL NO. _____ THROUGH _____

ENGINEERING PARTS LIST
Gear Box - M.L.G. Mechanism

ASSEMBLY DRAG. —
QUANTITY _____

ITEM NO.	DRAWING NO.	CHG. LET.	NAME	Quan. Per Unit	Total Quan.	MATERIAL	SPECIFICATION	PATTERN NO. OR MIN. STK. SIZE
1	1408B14	A	Shim - Bearing	1		.002 Lam. Brass Shim Stock	Commercial	2 sq. x .032 thk.
2	1436B11	—	Shim - Bearing	1		.002 Lam. Brass Shim Stock	Commercial	2½ sq. x .032 thk.
3	1650R24	R	HOUSING - SUB-ASSEMBLY	1		CONSISTS OF ITEMS 4, 22, & 23.		
4	1650R24-1	~	Housing - Main	1		356-T6 Alum. Alloy	QQ-A-601a	Pattern No. 1650R24
5	1650E25-1	~	Cover - Housing	1		356-T6 Alum. Alloy	QQ-A-601a	Pattern No. 1650E25
6	1650E25	L	COVER - SUB-ASSEMBLY	1		CONSISTS OF ITEMS 5, 9, & 23.		
7	1650C27	A	Retainer - Bearing	1		1020 Steel or equiv.	QQ-S-633	3½ dia. x 1-1/16 lg.
8	1650D28	F	Shaft - Input	1		4620 Steel	AMS 6294C	2-3/8 dia. x 10½ lg.
9	1650C29	A	Liner - Bearing	2		1020 Steel or equiv.	QQ-S-633	2-3/4 dia x 7/8 lg.
10	1650C30	D	Sleeve - Bearing	1		4130 Steel	MIL-S-6758	3½ dia x 1½ lg.
11	1650D140	B	Gear - Bevel	1		4620 Steel	AMS 6294C	3-3/4 dia x 1-3/4 lg.
12	1650B32	—	Shim - Bearing	1		.002 Lam. Brass Shim Stock	MIL-S-5697a	2½ sq. x .032 thk.
13	1650D188	—	Gasket	1		Vellumoid	HH-P-96C	5½ x 8½ x .006 thk.
14	1650C34	J	Adapter - Bearing	1		ALUM. ALLOY 356-T6	QQ-A-601A	PATTERN NO. 1650C34
15	1650B35	—	Shim	1		.002 Lam. Brass Shim Stock	MIL-S-5697a	4-1/8 sq. x .032 thk.
16	1650B36	A	Washer	1		1020 Steel or equiv.	QQ-S-633	1" dia. x 3/16 lg.
17	1650B37	A	Shim - Bearing	1		.002 Lam. Brass Shim Stock	MIL-S-5697a	3½ sq. x .032 thk.
18	1650D40	G	Gear - Output	1		4620 Steel	AMS 6294C	3-5/8 dia. x 3-5/8 lg.
19	1650D141	C	Gear - Intermediate Spur	1		4620 Steel	AMS 6294C	3-5/8 dia. x 3-3/16 lg.

	MADE	CHECKED	APPROVED
BY		[illegible]	[illegible]
DATE		12-16-57	12-[illegible]

WESTERN GEAR WORKS
LYNWOOD CALIFORNIA

SHEET 1 OF 3 SHEETS

FILE NO. BPL 2393

CHG —

F-3

FORM 9001B-21

CUSTOMER Lockheed Aircraft Corp.
SERIAL NO. _____ THROUGH _____

ENGINEERING PARTS LIST
Gear Box - M.L.G. Mechanism

ASSEMBLY DRWG. 1650E319
QUANTITY _____

ITEM NO.	DRAWING NO.	CHG. LET.	NAME	Quan. Per Unit	Total Quan.	MATERIAL	SPECIFICATION	PATTERN NO. OR MIN. STK. SIZE
20	1650E19	B	SPACER - BEARING	1		1025 TUBING	MIL-T-5066	1 3/16 DIA. x .189 WALL x 1/4 LG.
21	1650B...	-	Nameplate	1		Make from plate no. 9901B-24		
22	1462B6	C	LINER-BEARING	1		SHELBY SEAMLESS TUBING	COMMERCIAL	x 5/8 LG. 1-7/8 O.D. x 1½ I.D.
23	1589B8	D	LINER-BEARING	2		1020 STL.	AN-QQ-S-646	2 DIA x 5/8 LG.
(1) 24			Bearing - Ball	1		BRG ALT SEE 1650B23	ABEC-1 5205H	SKF Industries Los Angeles, Calif.
(2) 25			Bearing - Ball	1		BRG ALT SEE 1650B23	ABEC-1 6004J OR 6004XJ	SKF Industries Los Angeles, Calif.
(3) 26			Bearing - Ball	2		BRG ALT SEE 1650B23	ABEC-1 6005J	SKF Industries Los Angeles, Calif.
(4) 27			Bearing - Ball	2		BRG ALT SEE 1650B23	ABEC-1 6206J	SKF Industries Los Angeles, Calif.
28								
29			Seal - Oil	1		COR. RES. SPRING CAD PLATED CASE	63 X 223	Garlock Packing Co. Palmyra, New York
30			Seal - Oil	2		COR. RES. SPRING CAD PLATED CASE	63 X 237	Garlock Packing Co. Palmyra, New York
31			Pin - Dowel	1			AN122705	
32			Pin - Dowel	1			AN122692	
33			Insert	8			RD206SB-8	Rosan, Inc. Newport Beach, Calif.
34			Lockring	8			RLR28SB-8	Rosan, Inc. Newport Beach, Calif.
35			Insert	4			RD205SB-7	Rosan, Inc. Newport Beach, Calif.
36			Lockring	4			RLR24SB-7	Rosan, Inc. Newport Beach, Calif.
37			Lockring	8			RLR21SB-6	Rosan, Inc. Newport Beach, Calif.
38			Stud	8			SF91-7SA9A	Rosan, Inc. Newport Beach, Calif.

	MADE	CHECKED	APPROVED
BY	AC	[illegible]	[illegible]
DATE	6-3-57	12-16-57	12-17-57

WESTERN GEAR WORKS
LYNWOOD CALIFORNIA

SHEET 2 OF 3 SHEETS

FILE NO. BPL 2393

CHG D

F-4

CUSTOMER Lockheed Aircraft Corp.
SERIAL NO. ______ THROUGH ______

ENGINEERING PARTS LIST
Gear Box - M.L.G. Mechanism

ASSEMBLY DRWG. 1650[illegible]
QUANTITY ______

ITEM NO.	DRAWING NO.	CHG. LET.	NAME	Quan Per Unit	Total Quan	MATERIAL	SPECIFICATION	PATTERN NO. OR VIN. STK. SIZE
39			Bolt - Aircraft Machine	4			AN4CH[illegible]	
40			Screw - Fillister Head Machine	4			AN501AC10-12	
41			Screw - Drive	2			AN535-0-2	
42			Nut - Self Locking	1			AN364-524	
43			Nut - Self Locking	8			AN365-1032	
44			Washer - Flat	8			AN960C10L	
45			Washer - Flat	4			AN960C416L	
46			Nut - Lock	1		Shurlok	BL-N-05	Edward D. Maltby, Co. Los Angeles, Calif.
47			Lockwire	AR			AN995C32	
48			Grease	AR			MIL-G-3278	
49			Primer - Zinc Chromate	1 PT.			MIL-P-6889A	
50	16508327	—	GASKET - BEARING RETAINER GEAR BOX M.L.G. MECHANISM	[illegible]		VELLUMOID	HH-P-96C	[illegible] SQ. X .006 TH'K.
51								
52								
53								
54								
55								
56								
57								

(A) (5)

	MADE	CHECKED	APPROVED
BY	[illegible]	[illegible]	[illegible]
DATE	[illegible]	12-16-57	[illegible]

WESTERN GEAR WORKS
LYNWOOD CALIFORNIA

FILE NO. EPL [illegible]393

CHG D

F-5

FORM 90C38-21

PRODUCTION ☐ ACCOUNTING ☐ RELEASE DATE

ORIGINAL CUSTOMER	LOT NUMBER	QUAN.	CHARGE TIME TO
Lockheed A/C			1650-24

PART NAME	PLAN. TYPE	PLAN. REV.	DWG. NO.	REV.
Main Housing	4	AA	1650 R 24	S

MAT'L	SIZE	FORM	
356-T6 Alum. Alloy		Casting	

	O.P.C. NO.	REV.

	MAT'L SPEC. NO.	
	QQ-A-601 A	

BAR NO.	P.O. NO.	VENDOR	S.O. NO.

OPER. NO.	DEPT. NO.	MACH. GROUP	MACH CODE	1ST ART STAMP	OPERATION AND TOOL	SET-UP STD. TIME	INSPECT OK & NO.	PCS. FIG. GOOD	PCS. FIG. REJ.	DATE FIG.
	CAUTION:				"FIRST PIECE INSPECTION IS MANDATORY AT EACH MACHINE CENTER. IF LINE INSPECTOR IS NOT AVAILABLE, A LINE SUPERVISOR SHALL VERIFY BLUEPRINT COMPLIANCE".					
20	33				Material Lab Clearance Move material from casting stores; Furnish separated tote box	8.0 0				
30	147	5146			Serialize parts with lot control number	.05				
40	2	7275	3		Finish mill large face holding .69 dim to .66 min. depth within a 3.400 dia. envelope. Mill end of (1) ear, drill and tap (8) 1/4-20 holes. Rough bore 4.125 and 4.375 dia. bores. Finish bore 1.750 dia. for liner. Rough face, turn and bore all cross bores. Hold 2.594 center line dim. to 2.610/2.615 typ. both ends. Hold 3.248 hub dia's to 3.300 Finish bore 1.970/1.971 dia. per B/P for liner. Drill and tap hub end per B/P.	2.1* .50*				
		Tool			Special Vise Jaws (Milwaukee-Matic) 1650-24-61 N.C. Tape 1650-24-460-40					

PLANNER	TYPIST	APPROVAL	DATE PLANNED	SHEET NO.	OF
K	VC	Retyped 7-23-70	2-6-56	1	6

WGC FORM NO. 43-MODM-1

WSC FORM NO. 40-MOUM-4

M F G.

CUSTOMER: Lockheed A/C | LOT NUMBER | QUAN. | CHARGE TIME TO: 1650-24 | O R D E R

PART NAME: Main Housing | DWG. NO.: SEE FIRST PAGE

OPER. NO.	DEPT. NO.	MACH. GROUP	EACH COND	1ST ART STAMP	OPERATION AND TOOL	SET-UP STD. TIME	INSPECT OK & NO.	PCS. FIN. GOOD	PCS. FIN. REJ.	DATE FIN.
	CAUTION:				"FIRST PIECE INSPECTION IS MANDATORY AT EACH MACHINE CENTER. IF LINE INSPECTOR IS NOT AVAILABLE, A LINE SUPERVISOR SHALL VERIFY BLUEPRINT COMPLIANCE".					
45	143	2100			Burr per B/P. Break edges .015 max.	0 .13				
50	131	3200			Alodine #600 per B/P.	10.4 0				
60	160	2000			Draw from stores	5.0 0				
					1462-6 Liner 1589-8 Liner	(1 req'd per unit) (1 req'd per unit)				

PLANNER: H | TYPIST: vc | APPROVAL: Retyped 7-23-70 | DATE PLANNED: 2-5-56 | SHEET NO.: 2 | OF: 6

F-7

F-7

WBC FORM NO. 40-MODM-4

CUSTOMER	LOT NUMBER	YEAR	CHANGE TIKZ TO
Lockheed A/C			1650-24

PART NAME	DWG. NO.
Main Housing	SEE FIRST PAGE

OPER. NO.	DEPT. NO.	MACH. GROUP	MACH COND	1ST ART STAMP	OPERATION AND TOOL	SET-UP STD. TIME	INSPECT OK & NO.	POS. PCS. GOOD	POS. PCS. REJ
	CAUTION:				"FIRST PIECE INSPECTION IS MANDATORY AT EACH MACHINE CENTER. IF LINE INSPECTOR IS NOT AVAILABLE, A LINE SUPERVISOR SHALL VERIFY BLUEPRINT COMPLIANCE".				
70	141	7000			Shrink and assemble sleeves and install hardware per B/P.	0 .10			
80	2	9100			Sand large joint face for flatness	0 .08			
90	2	7376	3		Finish machine joint face bores, cross bores and hub end faces and chamfers per B/P.	2.25* .29*			
	2	7275	3						
		Tool			Locating Fixture (Milwaukee-Matic) 1650-24-62 N.C. Tape 1650-24-461-90 Nut Arbor (Concentricity) 1650-24-101				

F-8

PLANNER	TYPIST	APPROVAL	DATE PLANNED	SHEET NO.	OF
N	VC	Retyped 7-23-70	2-6-56	3	6

F-8

CUSTOMER	LOT NUMBER	QUAN.	CHARGE TIME TO
Lockheed A/C			1650-24

PART NAME	DWG. NO.
Main Housing	SEE FIRST PAGE

OPER. NO.	DEPT. NO.	MACH. GROUP	MACH. CONT.	1ST ART. STAMP	OPERATION AND TOOL	SET-UP STD. TIME	INSPECT OK & NO.	PCS. PER GO	PCS. PER REJ
	CAUTION:				"FIRST PIECE INSPECTION IS MANDATORY AT EACH MACHINE CENTER. IF LINE INSPECTOR IS NOT AVAILABLE, A LINE SUPERVISOR SHALL VERIFY BLUEPRINT COMPLIANCE".				
100	2	0361	2		Drill and ream (1) .1240/.1245 dia. hole per B/P.	.5* .04*			
		Tool			Drill Jig 1650-24-12				
110	143	2100			Burr	0 .25			
120	147	5147			Inspect	.3 .50			
		Tool			Checking Fixt. 1650-24-18				

F-9

PLANNER	TYPIST	APPROVAL	DATE PLANNED	SHEET NO.	OF
A	VC	Retyped 7-23-70	2-6-56	4	6

WGC FORM NO. 40-MODM-2

CUSTOMER	LOT NUMBER	QUAN.	CHANGE TIME TO
Lockheed A/C			1650-24

PART NAME	DWG. NO.
Main Housing	SEE FIRST PAGE

OPER. NO.	DEPT. NO.	MACH. GROUP	MACH COND	1ST ART STAMP	OPERATION AND TOOL	SET-UP STD TIME	INSPECT OR G NO.	POS. TOL. GAGE	REJ
	CAUTION:				"FIRST PIECE INSPECTION IS MANDATORY AT EACH MACHINE CENTER. IF LINE INSPECTOR IS NOT AVAILABLE, A LINE SUPERVISOR SHALL VERIFY BLUEPRINT COMPLIANCE".				
130	147	5124			Zyglo inspect (Certified)	0 .15			
140	131	3200			Alodine #600 per Spec. MIL-S-5541	10.4 0			
150	147	5146			Check for identification and package	0 .10			

F-10

F-10

PLANNER	TYPIST	APPROVAL	DATE PLANNED	SHEET NO.	OF
H	VC	Retyped 7-23-70	2-6-56	5	6

WGC FORM NO. 40-M01-M

CUSTOMER	LOT NUMBER	QUAN.	CHARGE TIME TO
Lockheed A/C			1650-24

PART NAME	MFG. NO.
Main Housing	SEE FIRST PAGE

OPER. NO.	DEPT. NO.	MACH. GROUP	MACH. COND.	1ST ART. STAMP	OPERATION AND TOOL	SET-UP / STD. TIME	INSPECT OK & NO.	PCS. GOOD	
	CAUTION:				"FIRST PIECE INSPECTION IS MANDATORY AT EACH MACHINE CENTER. IF LINE INSPECTOR IS NOT AVAILABLE, A LINE SUPERVISOR SHALL VERIFY BLUEPRINT COMPLIANCE".				
155	160	2000			Draw from stores and move to:	5.0 / 0			
					RD 205 SB-7 Insert	(4 req'd per unit)			
					RLRR 24 SB-7 Lockring	(4 req'd per unit)			
					RD 206 SB-8 Insert	(8 req'd per unit)			
					RLRR 28 SB-8 Lockring	(8 req'd per unit)			
					SF 91-7 SA-9A Stud	(8 req'd per unit)			
					RLRR 21 SB-6 Lockring	(8 req'd per unit)			
					SEE ALT TO FIND № 4 & 6				
157	141	7000			Install hardware per B/P.	0 / .50			
160	160	9000			Send to A/C stores	0			
					F 11	3.6* / .83*	F-11		

PLANNER	TYPIST	APPROVAL	DATE PLANNED	SHEET NO.	OF
H	JD	Retyped 7-23-70	2-6-56	6	6

WESTERN GEAR CORPORATION
PRECISION PRODUCTS DIVISION Lynwood, California

QUAN. / LOT NO.		CHARGE TIME TO 1650-319	REV G
ASS'Y SERIAL NO.		DWG. NO. 1650 R 319	REV.
CUSTOMER Lockheed A/C	CUST. P.O. NO.	CUST. DWG. NO.	REV.
PART NAME Gear Box M.L.G. Mechanism	W.G.C. S.O. NO.	ASS'Y COMPONENTS REC.	REV.

OPER. NO.	DEPT. NO.	ASSEMBLY INSPECTION RECORD	C D	MECH.	INSP.	DATE
10	160	Issue parts per basic parts list. Issue component parts as req'd per B/P.			XXX	
20	141	Record Unit S/N_____		XXX		
30	141	Layout parts for visual inspection and conformation to detail drawings. Inspect for required finish and absence of nicks and burrs.				

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F-

PLANNER	TYPIST	APPROVAL		DATE PLANNED	SHEET NO.	OF
McNab	vc		Retyped 5-5-70	11-26-68	1	4

WESTERN GEAR CORPORATION
PRECISION PRODUCTS DIVISION Lynwood, California

CUST.	LOT NO.	ORDER NO.	REV.
		1650-319	
ASS'Y SERIAL NO.		DWG. NO. SEE FIRST PAGE	

CUSTOMER: Lockheed A/C
PART NAME: Gear Box M.L.G. Mechanism

OPER. NO.	DEPT. NO.		ASSEMBLY INSPECTION RECORD	DWG NOTE	DWG ZONE	C D	MECH.	INSP.	DATE
40	141		GENERAL ASSEMBLY NOTES						
		1	Pack bearings and fill gear tooth spaces using MIL-G-3278 grease (Ref. B/P Note # 1)						
		2	Check backlash using 1.625 radius measured at the input shaft shall be .012/.026 or at output shaft shall be .007/.014 measured backlash locking respectively opposite shaft to housing. (Ref. B/P Note # 4)						
		3	Torque AN 364-524 nut to 60-85 Lb/In. (Ref. B/P Note # 6)						
		4	Generously cover remaining gear surface with MIL-G-3278 grease. (Ref. B/P Note # 1)						
		5	Torque BL-N-05 lockout to 800/1000 Lb/In. (Ref. B/P Note # 6)						
		6	Inspect gear tooth contact				XXX		

1.0

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PLANNER	TYPIST	APPROVAL		DATE PLANNED	SHEET NO.	OF
McNab	vc		Retyped 5-5-70	11-26-68	2	4

WESTERN GEAR CORPORATION
PRECISION PRODUCTS DIVISION Lynwood, California

QUAN.	LOT NO.	CHARGE TIME TO	REV.
		1650-319	
ASS'Y SERIAL NO.		DWG. NO. SEE FIRST PAGE	

CUSTOMER: Lockheed A/C

PART NAME: Gear Box M.L.G. Mechanism

ASSEMBLY INSPECTION RECORD

OPER. NO.	DEPT. NO.		DWG NOTE	DWG ZONE	C D	MECH.	INSP.	DATE
50	141	INSTALL NAMEPLATE USING ZINC CHROMATE PRIMER ON HOUSING, BACK OF NAME PLATE AND IN DRIVE SCREW HOLES. LOCKWIRE PER B/P REF B/P NOTE 2.					XXX	
70	142	ACCEPATANCE TEST 0.5 ...						
		NOTE: Test requirements must be in accordance with T O 16GI-89-3 Manual						

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PLANNER	TYPIST	APPROVAL		DATE PLANNED	SHEET NO.	OF
McNab	vc		Retyped 5-5-70	11-26-68	3	4

WGC-FORM ... KELLOGG BUSINESS FORMS CO.

WESTERN GEAR CORPORATION
[illegible] PRODUCT DIVISION

C.O.I.N.	LOT NO.	CHARGE TIME TO	REV.
		1653-[illegible]9	
A/C SERIAL NO.		DWG. NO. SEE FIRST PAGE	

CUSTOMER: Lockheed A/C

PART NAME: Gear Box M.L.G. Mechanism

OPER. NO.	DEPT. NO.	ASSEMBLY INSPECTION RECORD	DWG NOTE	DWG ZONE	C D	MECH.	INSP.	DATE
80	1[illegible]5	Mask off and paint unit with (2) coats of zink chromate primer per Spec. MIL-P-6889 A. Do not paint extending shafts and mounting surfaces. (Ref. B/P Note # 3)						
90	147	Visual inspect				XXX		
100	146	Stamp as req'd and protect				XXX		
110	160	Send to A/C Ass'y. Inspection						

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PLANNER	TYPIST	APPROVAL		DATE PLANNED	SHEET NO.	OF
McNab	vc		Retyped 5-5-70	11-26-68	4	4

APPENDIX G:

DOUGLAS N/C FABRICATION FACILITY - SUPPLEMENTARY DATA

List of 420 Vocabulary Words in Use In Current Computer Programs

Action Code Release

Action Group

Action Group - Backup

Action Group - Report

Activity Flag

Advance Assembly Outline

Advance Material Order

Aircraft Group

Aircraft Transport Association Code

Airplane Zone

Assembly Drawing Flag

Assembly Outline Number

Assembly Outline Pull Sequence

Assembly Start Date

Assembly Start Date - Fabrication Outline

Basic ECP (Engineering Change Proposal)

Basic Material Code

Basic Shop Order Quantity

Bin Location

Bin Location - Pull

Bin Number

Block Stamp Assembly Description

Boost Date

Cancel Date

Canel Flag

Catalog Sequence Number

Change Letter - Release

Change Letter - Tooling

Change Letter Description

Change Letter Requirements

Change Letter Sequence Code

Change Package Identifier

Changes Pending Material Action

Code - Document Type

Code - Handling Instruction

Code - Release Variance

Code - Single or Combined

Code - Special Schedule Identity

Code - Stop

Commercial Spares Release Date

Commercial Spares Release Quantity

Commonality Code

Commonality Code Part Used on More Than One Model

Complete Assembly Sequence File Letter Change

Configuration Dash

Configuration Date

Configuration Flag

Configuration Note

Configuration/Foreign Usage Code

Contract Item Specification Number

Contract Item Supplemental Purpose Description

Control Code

Coordination Data - Assembly Outline

Coordination Data - Fabrication Outline

Correction Narrative

Correction Action Type

Current Station Date

Current Station Number Condition

Customer Designated AO Effectivity (Assembly Order)

Customer - Exception

Customer Initial

Customer Initial WAS

Customer Item

Customer/Version Exception Code

Data Routing Supplier

Date - Auxiliary Release

Date - Calendar

Date - Completion Fabrication Outline

Date - Current

Date - Earliest Release

Date - End

Date - JCC Completion (Job Control Card)

Date - MPR Completion (Manufacturing Part Requirement)

Date - Production Release

Date - Pull

Date - Start

Date - Variable Release

Date of Inspection Buy-Off

Date Purge

Date Transaction On File

Department - Source

Design Cognizance

Design Control Document

Design Control Document Change Notice

Design Group

Detail Part Note

Detail Specification

Detail Type Specification

Direct Engineering Estimates

Discrepancy Specified on Rejection Form

Disposition Code

Disposition of Douglas Item

Disposition of Vendor Item

Disposition Specified on Rejection Form

Drafting Material Code

Drawing Number

Drawing Number - Replacing

Drawing Number Replaced

Drawing Replaced by

Drawing Replaces

Drawing Size

Drawing Title

Drawing Type

Drawing Zone

Due Out of Group

Edition Number

Effectivity - Matrix

Effectivity Action Indicator

Effectivity Factory Serial No. Plus/Minus

Effectivity Hundred

Effectivity Indicator

Effectivity Planning Next Assembly

Effectivity Statement - FSN

Effectivity Statement - Ship

Effectivity Type

Employee Number

Ending Fuselage

Engineering Change Proposal

Engineering Delete Code

Engineering Length

Engineering Material Code

Engineering Next Assembly

Engineering Next Assembly Dash Number

Engineering Note (Multiple Lines 40CH EA)

Engineering Order Process Date

Engineering Thickness

Engineering Width

Engineering Work Order

Engineers Note Code

Equipment Category

Expand Material Code

Fabrication Assembly Code

Fabrication Order Special Purpose Description

Fabrication Outline - Basic

Fabrication Outline - Split-1

Fabrication Outline - Split-2

Fabrication Outline Serial Number

Fabrication Schedule Code

Factory Serial Number

Federal Supplier Code

Figure Number

First Change Letter

First Delete Change Letter

First Reinstating Letter Change

Flight Development Engineering Order

Flight Development Release Order

FO Serial Number - End (Fabrication Order)

FO Serial Number - Start (Fabrication Order)

Form Serial Number

Furnished by Instruction

Group - Planning Assembly

Identifier for Item Requiring First Article for FAA (P/N Flag)

Indicator - Approved Part Number

Indicator - Assembly Date Equipment

Indicator - Basic Shop Order

Indicator - Delete

Indicator - Equipment Category

Indicator - Excess Release

Indicator - JCC Split (Job Control Card)

Indicator - Out of Position

Indicator - Part Common Usage

Indicator - Pull

Indicator - Schedule Code

Indicator - Serial/No Serial

Indicator - Set-Run

Indicator Effectivity Segment

Inspection Change Request

Inspection Characteristics List

Inspection Characteristics List Tooling

Inspection Code

Inspection Item Quantity

Interchangeable/Replaceable/Spare Code

Inventory Management Code

Issue Number

Item Find Number

Item Number

JCC - Action Required (Job Control Card)

Laboratory Tested

Last Change Letter

Last E.O. Revision Date (Engineering Order)

Last Incorporated Change Letter

Last Memo Number

Line Number - Dynamic

Line Number - Early Dynamic

Line Position

Maintenance and Overhaul Code

Maintenance Percent

Make From Part Name

Make From Stock Size

Manufacturers Code

Manufacturing Dollars for Rework

Manufacturing Dollars for Scrap

Manufacturing Index

Manufacturing Index - Earliest

Manufacturing Index - Next

Manufacturing Index Over-Ride

Manufacturing Length

Manufacturing Width

Master Part Record Change Authority

Master Part Record Coordination Data (5 x 70)

Master Parts Record Customer Effectivity

Master Tool Source

Material Category Code

Material Code

Material Date

Material Description

Material Dollars for Rework

Material Dollars for Scrap

Material Ending Fuselage Number

Material Expansion Code

Material Involvement Indicator

Material Qualifier

Material Sequence

Material Specification

Material Starting Fuselage Number

Material Substitute

Maximum-Length

Maximum-Width

Model Code

Model Version

Model Version - WAS

Model Version Exception

Modification Drawing Appl. Code

MPR Finish Area (Manufacturing Part Requirement)

MPR First Ship Effectivity (Manufacturing Part Requirement)

MPR - Note (2 x 70) (Manufacturing Part Requirement)

Multiple Use

Name - Planner

Next Assembly Drawing Number

Numerical Series

Numerical Series Sequence

Numerical Series Table Identification

O K to File Date

Operator Number

Other Model

Page

Page - Effectivity Hundreds

Page Effectivity

Page Effectivity Code

Page End

Page Matrix

Parent Model

Part Code

Part Code - Assembly Outline

Part Earliest Manufacturing Index

Part Material Category

Part Number

Part Number - Approved Parent

Part Number Opposite Hand Dash

Part Serial Number

Part Subassembly Code

Part Type

Part Type Error Release

Parts List Flag

Password

Planning Authority - Auxiliary Shop Order

Planning Authority - Excess/Shortage

Planning Change Identifier

Planning Change Request

Planning Fabrication Group

Planning Finish Specification

Planning Function Code

Planning Hold Flag

Planning Identifier Code

Planning Next Assembly Requirements

Planning Release Date

Plant Responsibility

Position - Assembly Outline

Position - Next

Price Code

Product Support Group Code

Production Data Sheets Instruction

Production/Planning Next Assembly

Proprietary Code

Protect the Product Planning Supplement

Provisioning Code

Purchase Order Location

Purchase Order Number

Purchase Order Splits

Qualifier Print Code

Quality Assurance Record Manufacturing

Quality Assurance Record Receiving

Quality Assurance Record Source

Quality Assurance Stamp Number

Quality Authorized Substitute

Quality Item Quantity

Quality Stamp Number

Quantity - AO Required (Assembly Outline)

Quantity - AO Required Per Airplane (Assembly Outline)

Quantity - Auxiliary Shop Order

Quantity - Class Shop Order

Quartity - Detail Part Per Airplane

Quantity - Excess/Shortage

Quantity - Fabrication Outline

Quantity - New Parts Added/Revised

Quantity - Release

Quantity - Required Per Airplane

Quantity - Required Per Engineering Next Assembly

Quantity - Ship Remainder

Quantity as is Accepted

Quantity Actual

Quantity of Parts Accepted

Quantity of Parts in Lot

Quantity of Parts Per Production/ Planning Next Assembly

Quantity of Parts Reflected

Quantity Per N/A + OR (Next Assembly) ( )

Quantity Rework

Quantity Scrap

Reference Drawings - Assembly Outline

Register Number

Reinstating Letter Change

Reflecting Department (Location)

Rejection Code

Rejection Document Serial Number

Release - Increment of

Release Cut-In

Release Cut-Out

Release Date

Release Number

Remarks Inventory Segments

Removal Document Serial

Removal Item Ship Record

Replace or Superseding Number

Replaced by Part Number

Replacement Purchase Order Code

Replacement Purchase Order Number

Replaces Part Number

Requirement Per Next Assembly

Requirement Per Part

Responsibility/Change

Responsible Agency

Routing Department

Routing Operation - Fabrication Outline

Run-Time-Total

Run-Time-Unit

Schedule Code

Schedule Date

Schedule Table Code

Section Column Number

Section Manufacturing Index

Section Number

Self-Explanatory

Send Number - Military/Commercial Spares

SEO-ETC (Serial Engineering Order) (Engineering Group Tag)

Sequence Code

Serial Engineering Order Incorporation Date

Setback - Assembly

Setback - End Date
Setback - Part Code
Setback - Release Planning
Setback - Total
Setup Time - Unit
Ship Number - Scheduled
Ship Release Status
Ship Sets
Ship Shortage Number
Shop Number (Fuselage)
Shop Order - Auxiliary
Shop Order - Excess/Shortage
Shop Order - Release
Shop Order Number
Shortage Data
Sign (Excess/Shortage)
Source Code
Source Department
Source of Assignment
Source of Master Tools
Spare Part Classification
Special Schedule Code
Specification Change Notice
Specification Change Notice Approval Approval Form
Specification Change Notice Quote Request
Starting Fuselage Number
Station Number - Current
Station Number - Current Code
Station Number - Prior
Station Number - Prior to Prior
Stock Size
Stop-Order Date
Sub Sub System
Sub-Segment Effectivity Indicator
Subcontractor Code
Subsystem Section
Supplier Address
Supplier Data History
Supplier Name
Symptom Code (For Hardware)
System Defect Symptom Code
Technical Letter Change
Term Point - Next
Termination Point
Test Results
Time
Time Between Schedule Shop Visits
Time Between Shop Overhaul
Time Code
Title-Assembly Outline
Tool Number - Basic
Tool Number - Dash
Tooling - Assembly
Tooling - Fabrication
Tools - Assembly Added/Reworked
Tools - Fabrication Added/Reworked
Total Hours Run on Part
Total Set-Back
Transaction Code

Transaction Date

Turnover Summary Report

Type of Procurement

Type of Release

Unit of Measure

VIR Serial Number (Vendor Information Request)

Wire Inspection Check List Item No.

Work Breakdown Structure Identifier

Work Description - Assembly Outline

Work Description - Fabrication Outline

Work Order Authorization Number

Work Release Order

Aircraft System/Chapter Number